Dubakella Plantations Insect and Disease Project

Physical Sciences Report

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Table of Contents

Tables

Introduction

This report summarizes the physical environment of the Dubakella Plantations Insect and Disease project area and the potential physical changes to the environment due to implementation of the Proposed Action within the context of direct, indirect and cumulative effects. Proposed activities and connected actions that are analyzed include thinning, prescribed fire treatments, and road reconstruction and maintenance. These activities are analyzed because they can have impacts (both positive and negative) on soil and water resources.

Relevant Laws, Regulations, and Policy

Regulatory Framework

Land and Resource Management Plan

Standards and guideline for geology, soils, and water related to this project (LRMP, page 4-25) include:

- Analyze each land disturbing project for its effect on the appropriate 2nd or 3rd order watershed[1] to prevent excessive cumulative impacts on stream channel condition and water quality.
- Implement Best Management Practices (BMPs) for protection or improvement of water quality, as described in "Water Quality Management for National Forest System Lands in California[2]," for applicable management activities. Determine specific practices or techniques during project level planning using information obtained from on-site soil, water, and geology investigations.
- Implement Forest Soil Quality Standards (LRMP, Appendix O) and the Forest supplement of the regional BMPs for areas identified as having highly erodible soils. Specifically, apply the special practices dealing with timber harvest, site preparation, and road construction in highly erodible soils.
- Forest Soil Quality Standards (LRMP, Appendix O), in relation to ground cover, soil organic matter, and soil porosity will be used to protect soil productivity.
- Identify and treat areas with a degraded watershed condition in a cost-effective manner and according to beneficial use priorities. High priority items include domestic use, anadromous fish habitat, and sensitive species habitat. Improvement activities will be designed to meet Management Area objectives.
- Give full recognition to the tendency for erosion, mass land movement, and severe watershed damage potential when implementing vegetation management and related land management activities.
- Assess the potential impacts of vegetation management, road construction, and related activities on slope stability and watershed condition for areas identified as moderately or highly unstable.
- Dedicate no more than 15 percent of the land harvested by even-aged systems to non-productive purposes such as roads, trails, landings, etc.
- When watering roads for dust abatement, follow the following rules:
  - Allow drafting from fishery streams only where immediate downstream discharge is maintained at 1.5 cubic feet per second or greater.

[1] The average size of a 2nd or 3rd order watershed is about 1,000 acres. The smallest hydrologic unit delineated by the Shasta-Trinity National Forest is the 8th field sub-drainage (average size about 1,900 acres).
[2] National BMPs (USDA Forest Service, 2012) have replaced the Regional BMPs referenced in the LRMP.

- Allow drafting from ephemeral streams, intermittent streams, wetlands or constructed ponds provided that sufficient water quantity and quality remains to support associated wildlife species and riparian values.
- Never allow drafting to remove more than 50 percent of any stream discharge.

Standards and Guidelines for fire and fuels (LRMP, page 4-17) relevant to physical sciences include:

- Activity fuels that remain after meeting wildlife, riparian, soil, and other environmental needs will be considered surplus and a potential fire hazard. The amount and method of disposal will be determined in the ecosystem analysis.

Standards and Guidelines for Riparian Reserves (LRMP, page 4-54 through 4-58) include:

- Prohibit timber harvest in Riparian Reserves, except as described below:
  - Apply silvicultural practices for Riparian Reserves to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain Aquatic Conservation Strategy objectives.
- For each existing or planned road, meet Aquatic Conservation Strategy objectives by:
  - minimizing road and landing locations in Riparian Reserves.
  - preparing road design criteria, elements, and standards that govern construction and reconstruction.
  - preparing operation and maintenance criteria that govern road operation, maintenance, and management.
- Meet Aquatic Conservation Strategy objectives by:
  - reconstructing roads and associated drainage features that pose a substantial risk.
  - prioritizing reconstruction based on current and potential impact to riparian resources and the ecological value of the riparian resources affected.
  - closing and stabilizing, or obliterating and stabilizing roads based on the ongoing and potential effects to Aquatic Conservation Strategy objectives and considering short-term and long-term transportation needs.
- Existing culverts determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.
- Design fuel treatment activities to meet Aquatic Conservation Strategy objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fuels management activities could be damaging to long-term ecosystem function.
- Design prescribed burn projects and prescriptions to contribute to attainment of Aquatic Conservation Strategy objectives.
- Water drafting sites should be located and managed to minimize adverse effects on riparian habitat and water quality, as consistent with Aquatic Conservation Strategy objectives.
- Fell trees in Riparian Reserves when they pose a safety risk. Keep felled trees on-site when needed to meet coarse woody debris objectives.

The description of Riparian Reserve widths are specified for categories as follows (LRMP, pages 4-53 and 4-54):

- Fish-bearing Streams - Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a

distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.

- Permanently Flowing Nonfish-bearing Streams - Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.
- Seasonally Flowing or Intermittent Streams[3] - At a minimum, the Riparian Reserves must include:
  - The stream channel and extend to the top of the inner gorge,
  - The stream channel and the area from the edges of the stream channel to the outer edges of the riparian vegetation, and
  - Extension from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest.
- Unstable and Potentially Unstable Areas - At a minimum, the Riparian Reserves must include:
  - The extent of unstable and potentially unstable areas (including earthflows).

LRMP Soil Quality Standards

The following specific guidance for Shasta-Trinity National Forest soil quality standards (SQSs) is found in appendix O of the LRMP:

- Areas of detrimental soil disturbance that affect soil productivity, should not be of a size or extent that would result in a significant change in production potential for the activity area.
- Use the following threshold values to identify detrimental soil disturbance for an activity area:
  - Soil Productivity
    - Soil cover for erosion protection is sufficient to prevent the rate of accelerated soil erosion from exceeding the rate of soil formation. The kind, amount and distribution of soil cover necessary to avoid detrimental accelerated soil erosion is guided by the Region 5 Erosion Hazard Rating system(Chapter 50, R-5 FSH 2509.22) and locally adapted standard erosion models and measurements. For highly erodible soils (soils developed from granitic parent material), ground cover should be in excess of 90 percent and evenly distributed. Skid roads, trails, temporary roads, and landings would be tilled to the depth of I8 inches or more, straw mulched or respread slash, and planted.
    - Soil porosity is at least 90 percent of the total porosity found under undisturbed or natural conditions. Porosity is evaluated between 4 and 8 inches below the surface for soils with tree and shrub potential, and between 0 and 4 inches for soils with herbaceous potential.
    - Soil organic matter[4] in the upper 12 inches of soil is at least 85 percent of the total soil organic matter found under undisturbed conditions for the same or similar soils.
    - Surface organic matter is present in the following forms and amounts:
      - Litter and duff[5] occurs over at least 50 percent of the activity area.

[3] Intermittent streams are defined as any nonpermanent flowing drainage feature having a definable channel and evidence of annual scour. This includes ephemeral streams if they meet these two physical criteria.

[4] Soil organic matter is the organic fraction of soil. It includes plant, animal and microbial residues, fresh and at all stages of decomposition, and the relatively resistant soil humus.

[5] Litter and duff are the organic layers on top of mineral soil consisting of fallen vegetative matter in various stages of decomposition. Specifically referred to as O horizons in soil descriptions (Oi, Oe and Oa horizons). Litter includes woody material up to 3 inches in diameter.

- Large woody material, when occurring in forested areas, is at least 5 logs per acre in contact with the soil surface. Desired logs are about 20 inches in diameter, about 10 feet long and represent the range of decomposition classes[6]. Attempt to protect logs in decomposition classes 3 through 5 from burning and mechanical disturbance.
- Soil Moisture Regime is protected where productivity or potential natural plant community are dependent upon specific soil drainage classes.

- Soil Hydrologic Function[7]
  - Infiltration and permeability are not reduced to ratings of 6 or 8 as defined in Region 5 Erosion Hazard Rating system (Chapter 50, R-5 FSH 2509.22).

Timber Land Suitability Criteria

The following specific guidance for Shasta-Trinity National Forest timber land suitability criteria is found in appendix I of the LRMP:

- Active landslides and inner gorge areas are classified as physically unsuitable for timber production without irreversible damage to soils productivity or watershed conditions.

Desired Condition

The desired condition of soil resources is to maintain or improve soil productivity and prevent excessive surface erosion, mass wasting, and cumulative watershed impacts (LRMP, page 4-5).

The desired condition of water resources is identified in the Forest goals (LRMP, page 4-6):

- Maintain or improve water quality and quantity to meet fish habitat requirements and domestic use needs.
- Maintain water quality to meet or exceed applicable standards and regulations.

Management Areas

The Wildwood Management Area (MA) is the primary MA of the project area. The MA is at risk of undergoing cumulative watershed effects due to past human activities and natural processes. Soils with higher erodibility risks are found scattered throughout this MA. Highly serpentinized soil types and some south slopes are either noncommercial forest lands or marginally suitable lands. Water quality of the tributaries of South Fork Trinity River and Hayfork Creek are to be maintained or enhanced.

Small portions of the project area lie within the Hayfork, Indian Valley/Rattlesnake, and Beegum Management Areas, and the Chanchelulla Wilderness.

[6] Any of five stages of deterioration of logs. Class 1: fresh, hard logs or green trees with little soil contact; bark and many branches intact; low moisture content; biological activity limited to penetration of outer bark by boring insects. Class 2: hard logs in partial contact with the soil; few branches, but most bark intact; low to moderate moisture content; outer bark fully penetrated by boring insects; high level of biological activity in inner bark. Class 3: intact, soft logs in full contact with the soil; no branches or bark; high moisture content; very high biological activity in fully penetrated sapwood; some biological activity in heartwood. Class 4: intact to fractured cubical heartwood and bark; log mostly buried in the soil; very high moisture content; extremely high biological activity, mostly microorganisms and sub-microscopic invertebrates; fully penetrated by mychorrizal fungi and roots. Class 5: totally buried, fractured cubical heartwood; barely perceptible as a low mound on the forest floor; often unrecognizable without excavation; very high moisture content; high biological activity, mostly mychorrizal fungi and sub-microscopic invertebrates; high concentration of roots.

[7] Soil hydrologic function is the inherent capacity of a soil to intake, retain and transmit water.

Riparian Reserves

The purpose of riparian management is to maintain or enhance riparian areas and water quality by emphasizing streamside and wetlands management (LRMP, page 4-59). Multiple resource uses and activities will occur in support of, and to the extent that they do not adversely affect the maintenance of riparian area dependent resources (e.g., water quality). Integrated pest management and road reconstruction are permitted.

The Aquatic Conservation Strategy (ACS) objectives (LRMP, page 4-53) provide direction for management of Riparian Reserves. Objectives specifically related to physical sciences resources include:

- Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.
- Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.
- Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.
- Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.
- Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

Federal Law

National Environmental Policy Act (NEPA)

NEPA requires that the direct, indirect, and cumulative effects of a proposed action must be addressed and considered by the Forest Service. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action and occur later in time or some distance away, but are still reasonably foreseeable. Cumulative effects are the impact on the environment which results from the combination of the action with other past, present, and reasonably foreseeable future actions regardless of who undertakes such other actions.

A proposed action may be categorically excluded from further analysis and documentation in an EIS or EA only if there are no extraordinary circumstances related to the proposed action (FSH 1909.15 Chapter 30). Resource conditions that should be considered in determining whether extraordinary circumstances related to a proposed action warrant further analysis and documentation in an EA or an EIS include flood plains, wetlands, and municipal watersheds. The mere presence of one or more of these resource conditions does not preclude use of a categorical exclusion. It is the existence of a cause-effect relationship between a proposed action and the potential effect on these resource conditions and if such a relationship exists, the degree of the potential effect of a proposed action on these resource conditions that determine whether extraordinary circumstances exist.

Clean Water Act

The goal of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Basic requirements for compliance with the law include the following:

- BMPs are to be implemented to prevent or reduce the amount of pollution by nonpoint sources to a level compatible with water quality goals.
- Impaired waterbodies are to be identified by the state, and total maximum daily loads (TMDL) are to be established to limit pollutants for impaired waterbodies to the level necessary to implement applicable water quality standards.

National Forest Management Act

The National Forest Management Act (NFMA) recognizes the fundamental need to protect and improve the quality of soil and water. The Forest Service is required to manage lands so as not to impair the long-term productivity of soils. NFMA requires that timber will be harvested from National Forest System lands only where:

- Soil productivity, slope, or other watershed conditions will not be irreversibly damaged.
- Protection is provided for streams, streambanks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat.
- The harvesting system to be used is not selected primarily because it will give the greatest dollar return or the greatest unit output of timber.

Clean Air Act

The Clean Air Act gives authority and responsibility to the Forest Service by:

- Requiring compliance with substantive and procedural requirements imposed by a Federal, State, interstate, or local administrative authority or court.
- Requiring consultation with each State having delegated authority on all matters concerning the prevention of significant deterioration of air quality, visibility, air quality maintenance plan requirements, and nonattainment requirements.

The Clean Air Act allows the Forest Service to regulate and intervene when asbestos could potentially be dispersed into the air, causing pollution and risk to public health or the environment.

Executive Orders

Protection of Wetlands, Executive Order No. 11990

The Forest Service is to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands.

Floodplain Management, Executive Order No. 11988

The Forest Service is to avoid to the extent possible the long and short-term adverse impacts associated with the modification of floodplains.

State Law

Porter-Cologne Water Quality Control Act

The Porter-Cologne Act requires the North Coast Regional Water Quality Control Board (Regional Water Board) to adopt a water quality control plan (Basin Plan) that contains the guiding policies of water pollution management in the North Coast Region of California.

Asbestos Airborne Toxic Control Measure (ATCM) for Construction, Grading, Quarrying, and Surface Mining Operations

This ATCM requires the implementation of mitigation measures to minimize emissions of asbestos laden dust. The following dust control measures are to be implemented during any road construction or maintenance activity:

- Unpaved areas subject to vehicle traffic must be stabilized by being kept adequately wetted, treated with a chemical dust suppressant, or covered with material that contains less than 0.25 percent asbestos.
- The speed of any vehicles and equipment travelling across unpaved areas must be no more than fifteen miles per hour unless the road surface and surrounding area is sufficiently stabilized to prevent vehicles and equipment traveling more than 15 miles per hour from emitting dust that is visible crossing the project boundaries.
- Storage piles and disturbed areas not subject to vehicular traffic must be stabilized by being kept adequately wetted, treated with a chemical dust suppressant, or covered with material that contains less than 0.25 percent asbestos.
- Activities must be conducted so that no track-out from any road construction project is visible on any paved roadway open to the public.

Other Guidance

Forest Service Manual, Chapter 2530 – Water Resources Management

Water quality management policy includes the following:

- Promote and apply approved BMPs to all management activities as the method for control of non-point sources of water pollution, and for compliance with established state or national water quality goals.
- Include a water quality evaluation for all environmental analyses. Identify the water quality implications of proposed and alternative land management practices.

Forest Service Manual Chapter 2550 – Soil Management

The Forest Service Soil Management Manual (FSM 2550) establishes the following management framework for sustaining soil quality and hydrologic function while providing goods and services outlined in the LRMP.

- Manage ecosystems to maintain or improve soil quality.
- Collect and manage information about the properties, distribution, capabilities, condition, suitabilities, and limitations of soils associated with National Forest System lands in accordance with Agency inventory, monitoring, assessment and information management policies.
- Use chemical, physical, and biological soil properties to assess existing soil condition for watershed condition and ecological assessments.
- Use soil properties to assess the condition and potential effects on soils when planning and implementing project activities.

National soil quality objectives include:

- Inform managers of the effects of land management practices on soil quality. Determine if adjustments to land management practices are necessary to sustain and restore soil quality.
- Determine status and trend of ecological processes and functions through the evaluation of soil quality.

The Region 5 soil manual supplement (R5 FSM 2500, Chapter 2550, Supplement 2500-2017-1) direction applies to those lands dedicated to growing vegetation. Soil functions and indicators that are to be used for assessment and analysis to determine if the national soil quality objectives are being met include:

- Support for plant growth function (soil productivity)
  - Soil stability
  - Surface organic matter
  - Soil organic matter (SOM)
  - Soil strength
  - Soil moisture regime
- Soil hydrologic function
  - Soil stability
  - Soil structure and macro-porosity

The desired condition for each indicator is described as:

- For soil stability, an adequate level of soil cover is maintained to prevent accelerated erosion, and erosion prevention measures are effectively implemented following soil disturbing activities.
- The amount of organic material on top of the mineral soil is maintained at levels to sustain soil microorganisms and provide for nutrient cycling.
- The amount of organic matter within the mineral soil, indicated by the color and thickness of the upper soil horizon, is within the normal range of characteristics for the site, and is distributed normally across the area.
- The soil strength level is conducive to a favorable rooting environment for the desired plant species.
- For soil structure and macro-porosity, most of the area has soil structure and macro-porosity (pores 1 mm of larger) that is similar to the undisturbed, natural condition for the soil type and provides sufficient infiltration and permeability to accommodate precipitation inputs for the given climate.

The condition of the indicators are to be rated as good (meets desired condition), fair (partially meets desired condition), or poor (does not meet desired condition).

Forest Service Manual Chapter 2580 – Air Resource Management

The objectives of air resources management are:

- Control and minimize air pollutant impact from land management activities.
- Cooperate with air regulatory authorities to prevent significant adverse effects of air pollutants and atmospheric deposition on forest and rangeland resources.

Forest Service Manual Chapter 2880 – Geologic Resources, Hazards, and Services

Policy of the Geologic Hazards Program includes the following:

- Locate, design, and maintain facilities (such as roads, trails, bridges) and other management activities to avoid, minimize, or mitigate their susceptibility to, or causal effects on, geologic hazards.
- Integrate geologic hazards into the Agency's land management activities, including associated NEPA processes.
- Manage geologic hazards on NFS lands to ensure the protection of public safety, health, property, and the environment by using qualified Geologists for the recognition, inventory, analysis, and interpretation of those hazards, and the integration of that information into Forest

and project planning, design, construction, maintenance, and monitoring activities, reviews of proposals, permits, approvals, concurrences, and recommendations for uses of NFS lands.

Forest Service Region 5 FSH 2509.22 – Soil and Water Conservation Handbook, Chapter 10 – Water Quality Management Handbook[8]

Directions in draft form for water quality management includes the following:

- BMPs are the practices that both the Federal and State water-quality regulatory agencies expect the Forest Service to implement to meet its obligation for complying with applicable water quality laws and standards, and to maintain and improve soil, and water quality, and riparian resources (to the extent that they contribute to maintenance of chemical, physical, and biological water quality). BMPs address protection of water quality from new and ongoing activities. Restoration of water-quality problems resulting from past land uses (legacy sites) is also an important component of this plan.
  - Implement BMPs during all current management activities on all NFS lands in California.
  - Review and revise BMPs as needed to reflect the most recent state-of-the-art methods and techniques of BMP implementation and changes in Forest Service policy and direction.
  - Correct legacy water-quality problems where feasible.
  - Conduct monitoring as directed through USFS National BMP Monitoring Program, Forest Plans, and regulatory permits.
- NEPA analyses for timber harvest, fuels, and vegetation management activities that include ground-disturbing activities will include an inventory of controllable sediment discharge sources and other legacy sites that may affect water quality within project boundaries and along appurtenant Forest Service roads. Legacy sites will be restored either on a watershed or project basis.
- The Forest Service has current authority and direction to assess restoration needs and conduct restoration of legacy problems within the boundaries of timber sales, although restoration is limited by available funds generated by the sale of forest products or external grant funding.

Forest Service Region 5 FSH 2509.22 – Soil and Water Conservation Handbook, Chapter 20 – Cumulative Off-site Watershed Effects Analysis

Direction includes the following:

- Assess and consider the potential for cumulative watershed effects of proposed activities. The Forest Service Pacific Southwest Region Cumulative Watershed Effects policy uses the equivalent roaded area model to make a preliminary assessment of watershed conditions by comparing effects of past, existing, and reasonably foreseeable actions to a watershed threshold of concern. The assessment of potential cumulative watershed effects is included in NEPA analyses and can guide selection of alternatives by decision makers.

Forest Service Region 5 FSH 2509.22 Soil and Water Conservation Handbook Chapter 50 – Soil Erosion Hazard Rating

Direction for project planning and implementation includes the following:

- Make erosion hazard ratings (EHRs) during early stages of activity planning to provide a means to predict relative post-activity erosion hazard conditions and to integrate necessary erosion control measures into project design. Different EHRs for a specific site are calculated by

[8] Chapter 10 of the Region 5 Soil and Water Conservation Handbook (Amendment No. 2509.22-2011-1) expired in 2016. Its replacement has not yet been approved, but is available in draft form.

varying those factors that can be changed by the planned activity or by post-activity erosion control measures. This provides a comparison of the planned activity with alternative treatments and mitigation measures and permits selection of a desired post-activity erosion hazard. For example, a planned post-activity EHR is calculated to be high, but the desired rating is low. The soil cover factor can be adjusted until a low rating is achieved. The amount of soil cover needed to reduce the EHR to low is incorporated into the project design.

- For planned activities and site specific determinations, ratings are computed for representative, homogeneous units within an activity area. The climatic factor is constant over an activity area, but variations in soil, topographic and cover related factors may occur.
- Changes in soil related factors can be anticipated by changes in topography, vegetation, rock fragments, soil color and other surface soil conditions. Soil maps can serve as a guide to variations in soil related factors.
- A new rating is calculated where changes are noted because adjustments in planned treatments or mitigation measures may also coincide with these changes.

Water Quality Control Plan for the North Coast Region

Pertinent water quality objectives include:

- Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
- The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
- Turbidity shall not be increased more than 20 percent above naturally occurring background levels.
- The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.
- At no time or place shall the temperature of any cold water be increased by more than 5 °F (~3 °C) above natural receiving water temperatures.

Land management measures relevant to this project include:

- All roads within Riparian Management Zones[9] shall be surfaced with competent rock to a sufficient depth prior to use of the road to prevent road fines from discharging into watercourses.
- There is no removal of downed large woody debris from watercourse channels unless the debris is causing a safety hazard.
- There is no removal of trees from unstable areas within Riparian Management Zones that have the potential to deliver sediment to a water of the State unless the tree is causing a safety hazard.

North Coast Regional Water Quality Control Board Waiver of Waste Discharge Requirements

All activities managed by the Forest Service are to be conducted in compliance with the *Waiver of Waste Discharge Requirements for Nonpoint Source Discharges Related to Certain Federal Land Management Activities on National Forest System Lands in the North Coast Region* (Waiver). The Waiver (Cal. EPA,

[9] Riparian Management Zone is not the same as Riparian Reserve. The Riparian Management Zone width is 100 feet for perennial streams and 50 feet for intermittent streams.

Regional Water Board, 2015) is the implementation mechanism to address impaired watersheds. Several general conditions of the Waiver that are relevant to this project include:

- The Forest Service shall facilitate early Regional Water Board staff involvement in the project planning process for all projects that have a potential to impact water quality and for projects that will be covered by this Waiver. This includes project scoping, NEPA development and review, and pre- project consultations.
- The Forest Service shall manage and maintain designated riparian zones to ensure retention of adequate vegetative cover that results in natural shade conditions, within 300 feet slope distance on each side of fish- bearing streams, 150 feet slope distance on each side of perennial streams, and 100 feet slope distance on each side of intermittent streams, or the site potential tree height distance on each side of the stream, whichever is greatest. Exceptions to this condition will be considered. In order for Regional Water Board staff to determine the adequacy of the justification for an exception, the justification must identify the proposed canopy reduction and expected recovery time, provide an estimate of the pre- and post- project shade or solar impacts, and explain how such an exception will result in a net long- term benefit to water quality and stream temperatures.
- Compliance with all of the conditions of the Waiver constitutes compliance with sediment and temperature TMDL implementation. TMDL implementation includes: legacy sediment site inventories, prioritization, and treatment; retention of natural shade within designated riparian zones; and application of on-the-ground prescriptions that meet Forest Service BMPs for new activities.
- Activities conducted under this Waiver must be in compliance with water quality requirements, the Basin Plan, and amendments thereto.
- The discharge of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature into any stream or watercourse in quantities deleterious to fish, wildlife, or other beneficial uses is prohibited.
- The placing or disposal of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging construction, or associated activity of whatever nature into any stream or watercourse in quantities deleterious to fish, wildlife, or other beneficial uses is prohibited.

Two categories of activities are identified in the Waiver, Category A and Category B, which are grouped according to the level of potential impact to water quality. Activities that have a low potential impact to water quality are eligible for Category A. Activities that have a moderate potential impact to water quality are eligible for Category B. Category B conditions include:

- The Forest Service shall actively address all legacy sediment sites within the project area. Legacy sediment sites must be identified, inventoried, prioritized, scheduled, and implemented for treatment. The inventory shall be submitted to the Regional Water Board during project development. Successful implementation of treatments is required for Sediment TMDL compliance.
- The Forest Service shall submit a complete Waiver application.
- Activities shall be monitored to assure that prescribed BMPs are implemented and effective in avoiding any adverse impacts to water quality.

North Coast Regional Water Quality Control Board Monitoring and Reporting Program Requirements

Implementation monitoring shall be conducted for all Category B projects (Cal. EPA, Regional Water Board. 2015b). The purpose of implementation monitoring is to assess whether the project specific BMPs and on- the- ground prescriptions are fully and properly carried out and are functioning properly.

Implementation monitoring is the primary process for early detection of potential water- quality problems.

Road projects effectiveness monitoring assesses whether each new road project (e.g. new road construction or re- construction, crossing and culvert replacements, etc.) and the associated BMPs and on- the- ground prescriptions are effective in protecting water quality after one winter (Cal. EPA, Regional Water Board. 2015b). Effectiveness monitoring may be as simple as conducting a visual inspection of the project site and the BMPs or may require more in- depth assessment of the BMP site and adjacent area. Road project effectiveness monitoring shall be performed after a particular road project BMP has gone through at least one winter period in order to evaluate how well the project and BMPs functioned during winter rain events and/or spring snowmelt.

South Fork Trinity River and Hayfork Creek Sediment Total Maximum Daily Loads

Roads are the primary source of sediment from human activities (U.S. EPA, 1998). To decrease sediment delivery from roads, targets for the following conditions include:

- Stream crossings with diversion potential – less than 1 percent
- Stream crossings with significant crossing failure potential[10] – less than 1 percent
- Hydrologic connectivity – reduced to the extent feasible.
- Unmaintained roads will be hydrologically closed/disconnected (fills and culverts removed, natural hydrology of hillslope largely restored).

Regional Water Board Temperature Guidance[11]

Natural receiving water temperatures are the temperatures that occur when the factors controlling water temperature, including shade, flow, and channel morphology, are equivalent to their natural condition. In assessing natural temperatures, anthropogenic factors that may cumulatively act on a stream to alter its temperatures must be considered, including:

- Upstream flow alterations;
- Past canopy removal, either mechanically or as a result of increased sediment loads; and,
- Alteration of channel characteristics such as width, depth, and streambed permeability associated with geomorphic changes caused by altered sediment loads.

When stream temperatures have been altered in the past, the degree of temperature alteration must be evaluated to determine:

- Whether the existing temperatures meet the intrastate water quality objective for temperature;
- What beneficial uses may have been supported prior to alteration of the temperature; and,
- How much temperature increase can occur without exceeding the intrastate water quality objective for temperature.

Estimates of natural temperatures can be developed by comparison with reference streams.

[10] Culverts and crossings should be designed to pass the 100-year flood, including snowmelt, and associated debris and sediment, targeting crossings with the highest probability of failure and highest consequences.

[11] A temperature TMDL for the South Fork Trinity River sub-basin is not available, but the Regional Water Board has provided temperature guidance in *Staff Report Supporting the Policy for the Implementation of the Water Quality Objectives for Temperature and Action Plan to Address Temperature Impairment in the Mattole River Watershed, Action Plan to Address Temperature Impairment in the Navarro River Watershed, and Action Plan to Address Temperature Impairment in the Eel River Watershed* (2014).

Pacific Coast Federation of Fishermen's Associations. v. National Marine Fisheries Service, 265 F.3d 1028 (9th Cir. 2001)

The United States Court of Appeals for the Ninth Circuit ruled that because the evaluation of a project's consistency with the long-term, watershed level ACS objectives could overlook short-term, site-scale effects that could have serious consequences to a listed species, these short-term, site-scale effects must be considered.

Topics and Issues Addressed in This Analysis

Purpose and Need

Physical sciences resources are not driving all or part of the project's Purpose and Need for Action.

Issues

Issues identified through scoping in which physical sciences resources are directly related include:

- Effects to water quality of activities proposed in Riparian Reserves
- Current condition of roads, increased road use, construction and reconstruction
- Landing construction and fireline construction with the use of bulldozers
- Cumulative effects on water quality
- Unstable landscapes
- Treatment of legacy sediment sites, consultation with the North Coast Regional Water Quality Control Board, and communications with the Water Board
- Increase in sedimentation from project activities
- Compliance with the TMDL
- Number of road crossings in the project area
- Temporary roads and landings within Riparian Reserves
- Effects of prescribed burning on soils, sedimentation, water quality, and Riparian Reserves
- Effects of Wildwood grazing allotment on water quality.

Other Resource Concerns

Physical sciences resources concerns associated with law, regulation, and policy include geologically unstable areas, naturally-occurring asbestos, soil productivity, soil hydrologic function, the sediment and temperature impairment of the South Fork Trinity River sub-basin, and the physical complexity of stream channels.

Resource Indicators and Measures

Resource indicators that are used to measure and disclose effects include landslides and inner gorges; soil stability; surface organic matter; soil organic matter (SOM); soil strength, soil structure, and macro-porosity; sediment; temperature; and LWD (Table 1).

Table 1. Geologic, soil, and water resources indicators and measures for assessing effects.

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source
Geologic Stability	Landslides and inner gorges	Acres	No	FSM 2880

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source
Support for Plant Growth and Hydrologic Functions	Soil Stability	Soil Erosion Risk	No	R5 FSM 2500 Chapter 2550
Support for Plant Growth Function (nutrient conservation)	Surface Organic Matter	Sizes, Amount, and Distribution	No	R5 FSM 2500 Chapter 2550
Support for Plant Growth Function	Soil Organic Matter	Risk of SOM Loss	No	R5 FSM 2500 Chapter 2550
Support for Plant Growth and Hydrologic Functions	Soil strength, Soil Structure, and Macro-porosity	Compaction Risk	No	R5 FSM 2500 Chapter 2550
Water quality	Sediment	Equivalent Roaded Area (acres) and tons of sediment per square mile per year.	No	R5 FSH 2509.22 Chapter 20, US EPA South Fork Trinity River Sediment TMDL
Water quality	Temperature	Stream shading (%)	No	Waiver
Physical complexity of stream channel	LWD	Pieces per mile of stream	No	Forest Plan, Regional Water Board

Methodology

Geologically unstable areas and areas that are suspected of instabilities are evaluated. The Forest GIS coverages for bedrock and geomorphology are examined with proposed treatment areas and project roads superimposed to identify areas where unstable land might be impacted by project activities. Forest Service maps, GIS databases, and Google Earth images of the project area are examined to get a sense for the effects of the proposed action and to look for recent landslides which may have been missed by the Forest active landslide GIS coverage. Field data are collected primarily adjacent to roads using traditional methods such as maps, GPS, clinometer, and field book. Areas that show kinetic indicators of recent movement within the lifespan of the existing trees are mapped as active landslides, and areas that do not show recent movement are mapped as dormant. Areas with a high probability of mass wasting from ground disturbing activities are identified for protection.

Areas with ultramafic rock are mapped.

All soil units have been representatively sampled using the Forest Soil Disturbance Monitoring Protocol (FSDMP)[12] (Page-Dumroese and others, 2009). In the selected representative soil types, five soil disturbance monitoring transects have been evaluated.

Soil stability is assessed by evaluating soil erosion risk. The Region 5 Erosion hazard rating system is utilized along with the erosion model WEPP.

Surface organic matter is assessed by evaluating the expected changes in surface organic matter sizes, amount, and distribution.

[12] The FSDMP is the best available monitoring protocol due to the strength of its consistency, repeatability, and statistical validity.

Soil organic matter is assessed by evaluating the risk of loss of SOM due to displacement and prescribed burning.

Soil strength, soil structure, and macro-porosity are assessed by evaluating compaction risk based upon findings from the Long Term Soil Productivity (LTSP) study, forest soil quality monitoring, and other current science.

Soil units are mapped using the Shasta-Trinity National Forest GIS library. Thirty-five soil pits have been dug to confirm the soil map units.

A water quality evaluation identifies: (1) designated beneficial uses of the watersheds, (2) pollutants in the watersheds, (3) sources of the pollutants, and (4) causes of the pollutants.

The potential for cumulative watershed effects of proposed activities are assessed using the equivalent roaded area (ERA) model developed by Haskins (1983) to estimate the ERA within each hydrologic unit (HUC[13] 5 to 8). The results are compared against the ERA of the established threshold of concern[14] (TOC). All past, present, and reasonably foreseeable actions within the affected hydrologic units that can be accounted for are modeled. ERA disturbance factors used by the Shasta-Trinity National Forest were developed using the coefficients described by Haskins (1986), surrounding forests, scientific literature, and professional judgment. Disturbance factors for each type of activity are described by an equation of the form:

where y is the disturbance factor, a is a disturbance constant, b is a recovery coefficient, and x is duration in years. The disturbance factor y is multiplied by the activity area in acres to calculate the ERA for the assessment year.

Best management practices (BMPs) are identified to control nonpoint source pollution related to all management actions with the potential to affect water quality. BMPs are selected from the Forest Service National BMPs (USDA, Forest Service, 2012).

Legacy sediment sites are identified by inspecting all road/stream crossings within the project area. Culvert dimensions and bankfull widths are measured in the field with a tape measure. Crossings with diversion potential and hydrologically connected roads are identified in the field using a clinometer. Fill volumes are estimated by measuring distances with a field tape and slopes with a clinometer. Culverts are designed to accommodate the 100-year flood flow plus debris using the computer model StreamStats (Ries III and others, 2017) and the Federal Highway Administration culvert capacity nomograph with a 0.67 headwall-to-culvert diameter ratio (Weaver and others, 2015).

Reference streams are used to analyze the condition of streams in the proposed project area. Reference streams are locations that function as examples of undisturbed or minimally- disturbed conditions, and display an absence of significant anthropogenic disturbance or alteration (NCRWQCB, 2015b). Reference streams on the west side of the Shasta-Trinity National Forest include Powell, Potato Creek, and Bear Creek in the South Fork Trinity River sub-basin; and Grizzly Creek, Swift Creek, Panther Creek, Quimby Creek, Big French Creek, East Fork North Fork Trinity River, Stoney Creek, and East Fork Coffee Creek in the Trinity River sub-basin. Powell is located in the Yolla Bolly-Middle Eel Wilderness on the South Fork Trinity River. Potato Creek is located about one mile downstream from the Chanchelulla Wilderness.

[13] The hydrologic unit code (HUC) uniquely identifies each hydrologic unit. The number associated with the HUC relates to watershed size—higher numbers refer to smaller watersheds. Each hydrologic scale is represented by two numbers. A HUC 5 is a ten digit code, a HUC 7 is a 14 digit code, etc.

[14] TOC is a management level threshold of a watershed, where if exceeded, the risk of cumulative effects increase dramatically. TOC was established in the LRMP Final EIS only for HUC5s and HUC6s. Therefore, for HUC7s and HUC8s, the HUC6 TOC has been used to establish the TOC.

Bear Creek is located in a watershed that is designated as sediment and temperature impaired; however it is located in Bear Creek drainage, which has a very low road density (0.56 miles of road per square mile of area) with most of the roads located on ridge lines. Grizzly Creek and Swift Creek are located in the Trinity Alps Wilderness. Panther Creek, Quimby Creek, Big French Creek, East Fork North Fork Trinity River, and Stoney Creek are located in watersheds which are not impaired. Coffee Creek is located in a watershed that is designated as sediment impaired, but it is identified as a reference site in the Trinity River TMDL (U.S. EPA, 2001).

Potential stream temperature changes that could occur if the project is implemented are estimated from predicted changes in stream shading. Temperature and shading data collected in 2017 from five reference streams (Powell, Potato Creek, Big French Creek, Panther Creek, and East Fork North Fork Trinity River) shows that maximum weekly maximum temperature (MWMT) is well correlated to stream shading. MWMT can be estimated using the following equation[15]:

where T is the temperature in degrees Celsius and S is the stream shading in percent. Stream shading is measured following the Pacific Southwest Region Stream Condition Inventory protocol (USDA Forest Service, 2005). This equation is used to estimate stream temperature changes that could occur if the project is implemented.

Quantities of LWD in streams in the project area are compared to the amount of LWD in reference streams. The amount of LWD expected in a properly functioning stream can be estimated using the following tentative regression equation that has been developed for the west side of the Shasta-Trinity National Forest (Pickle and others, 2019):

where LWD[16] is the pieces per mile of stream and BFW is the bankfull width (feet) of the stream. This regression equation was developed from reference stream reaches with bankfull widths ranging from 13 to 41 feet.

Information Sources

Recommended riparian buffer zone widths vary widely depending upon their function and numerous site factors such as soil erodibility, soil permeability, slope, and vegetation type (U.S. Army Corps of Engineers, 1991; Broadmeadow and Nisbit, 2004; Hawes and Smith, 2005). Effective buffer widths for temperature control range from more than 30 feet up to 230 feet. Effective buffer widths for sediment control vary from 30 feet to more than 300 feet. Effective buffer widths for bank stabilization vary from 30 feet to about 100 feet. As slope increases, the rate of surface runoff flow increases; therefore, the steeper the land, the wider the buffer needs to be to have time to slow the flow of runoff and absorb sediments. Soil type affects how quickly water can be absorbed; soils that are high in clay are less permeable and may have greater runoff. Buffers with structurally diverse vegetation (a mix of trees, shrubs and grasses) are much more effective at capturing sediment than a riparian buffer that is solely trees. Brazier and Brown (1973) reported that maximum shading ability was reached with an 80 foot wide forest buffer to control temperatures in small mountain streams in Oregon. Moring (1982) found that a 30 meter wide riparian buffer along an Oregon stream protected gravel beds from sedimentation caused by logging so that salmon eggs and alevins developed normally. Beschta et al (1987) reported that riparian buffers with widths of 30 meters or more generally provide the same level of shading and maintain a

[15] $R^2 = 0.96$.

[16] LWD is defined as downed wood with at least a portion in the channel that has a length greater than half of the stream bankfull width (USDA Forest Service, 2005).

similar temperature regime to that of an old-growth forest in western Oregon. Curry et al. (2002) reported that a 20 meter wide riparian buffer was partially successful in protecting the thermal regime of spawning gravels in a Newfoundland trout stream. The Forest Service Pacific Northwest Research Station recommends an unmanaged riparian buffer in forested watersheds of the Pacific Northwest of about 30 meters to maintain stream banks, and about 50 meters to control sediment and maintain water temperature (Everest and Reeves, 2007).

Affected Environment

Existing Condition

The project area lies within the Klamath Mountains Physiographic Province and the South Fork Trinity River sub-basin.

The Klamath Mountains Physiographic Province is a rugged mountain range composed predominately of ophiolites[17]. Unstable geologic terrane is common in the province. The mild Mediterranean climate is characterized by hot dry summers and wet winters. About 90 percent of the precipitation falls between October and April; mean annual amounts are variable, ranging from about 40 to 80 inches. Some of the precipitation falls as snow. Rain occasionally falls on the existing snowpack, which can result in very intense flooding.

Geologic terranes in the Klamath Mountains were accreted to the western margin of North America by tectonic processes. These Terranes were intruded by granitic plutons. Most of the terranes are weak and prone to landslides. Rapid uplift, high precipitation, and seismic activity to the west have created a landscape with abundant deep seated landslides, many of which occupy several square miles. Most of these larger complexes are dormant under present climatic and seismic conditions, though some from tens to hundreds of acres in size are known to be active. Both the active and dormant landslides are very important parts of the landscape because they are often the source of debris slides during wet winters, and the debris slides in turn generate debris flows.

Serpentine and its parent material, ultramafic rock, are abundant in the Klamath Mountains (California Environmental Protection Agency, 2002; USDA Forest Service, n.d.b). Naturally-occurring asbestos is commonly found in ultramafic rock formations, including serpentine, and in the soils where these rock types are located (USDA Forest Service, n.d.a).

The South Fork Trinity River sub-basin can have high sediment-production rates, owing to the unstable geologic terrane, fragile soils, human activity, and high intensity storms (U.S. EPA, 1998). The South Fork Trinity River historically was one of the better salmon and steelhead streams in California. After a major flood in 1964, the fishery declined dramatically. Mass wasting caused by the flood resulted in dramatic instream changes, including channel widening, aggradation, and loss of pool depth – all of which adversely affected the fishery. Unstable geology and erosion-producing land use activities (road construction and logging) have been blamed.

The 1964 flood produced record flows estimated as a 100-year to 1,000-year event (Cal. DWR, 1979). Many mass wasting events occurred in the sub-basin for years following the flood. Numerous landslides and debris flows delivered considerable quantities of sediment to the South Fork Trinity River, resulting in channel aggradation and widening, decreased depths and numbers of pools, decreased numbers of fish,

[17] Ophiolite is a composite of the ocean crust consisting of marine sediments, volcanics and ultramafic rock. In mountain building areas, where ocean crust collides with continental crust, slabs of this composite are accreted to the continent. The ultramafic-bearing composite is termed an ophiolite. The largest ultramafic area in North America is associated with the Klamath Mountains Physiographic Province (USDA Forest Service, n.d).

increased amounts of fine sediments in the bed material, and increased temperatures associated with loss of riparian vegetation and decreased pool depths. The overall quantity of sediment delivery to the South Fork Trinity River has decreased since the flood, but chronic inputs of sediment from roads and episodic inputs from washouts and mass wasting continues. Some continued in-channel changes are also part of the natural cycle of adjustments to natural and management-induced events that would be expected following a major disturbance such as the 1964 flood (U.S. EPA, 1998).

An abundant fishery of chinook, coho salmon, and steelhead trout historically existed in the South Fork Trinity River sub-basin (Pacific Watershed Associates, 1994). Fish counts declined dramatically following the 1964 flood. In 1964, the spawning spring chinook population was estimated to be over 10,000; estimates during the early 1990s were just a few hundred. Fall-run chinook were estimated at 3,400 just prior to the 1964 flood, but between 1985 and 1990 the returns ranged from 345 to 2,460.

Logging began as early as 1949 in the South Fork Trinity River sub-basin, and grew in intensity throughout the area beginning in the 1960s (USDA FS, 1995). About 80 percent of the South Fork Trinity River sub-basin was originally occupied by forest, about half of which was logged by 1977 (Cal. DWR, 1979). The logging boom exacerbated the detrimental effects of the 1964 flood (U.S. EPA, 1998). In particular, construction of logging roads and stream crossings on the erodible geology altered the natural hillslope hydrology, causing significant erosion and sediment impairment.

The Dubakella sub-watershed lies within the Upper Hayfork Creek watershed and the South Fork Trinity River sub-basin. Major streams in the sub-watershed include Hayfork Creek, Dubakella Creek, Stringbean Creek, Goods Creek, Hall City Creek, Wilson Creek, and Chanchelulla Gulch. Hayfork Creek and Dubakella Creek have been identified as important to the distribution and viability of fish stocks at risk (Shasta-Trinity National Forest, 1998).

Fire is a significant disturbance factor within Upper Hayfork Creek watershed (Shasta-Trinity National Forest, 1998). Prior to the initiation of organized fire suppression in the early 1900s, low intensity surface fires of relatively short intervals were typical. Fire suppression along with unnatural fuel loading has caused a transition to a fire regime characterized by more frequent high severity fires. Several high severity fires have occurred within the Dubakella sub-watershed, including the 2015 fires. Large-scale forest fires have caused continued accelerated sediment production in many areas in the South Fork Trinity River sub-basin (U.S. EPA, 1998).

Three geologic terranes and a pluton occur within the Dubakella sub-watershed: the Sawyers Bar, Western Hayfork, and Rattlesnake Creek Terranes; and the Wildwood Pluton (Appendix A). The Rattlesnake Creek Terrane is an accretionary mélange consisting mostly of highly dismembered ophiolite, including slabs of serpentinite and peridotite, basaltic volcanic rocks, radiolarian chert, and limestone outcrops; a significant proportion consists of diamictite – a highly erodible metasedimentary rock. The Sawyers Bar Terrane consists primarily of metasedimentary rock; it contains a scattering of dormant landslide deposits, primarily slump and earthflow complexes. The Western Hayfork Terrane consists mainly of metavolcanic agglomerate and tuff, as well as argillite and chert; a few dormant landslides are found in this Terrane. The Wildwood Pluton contains minor amounts of pyroxenite which could also possibly contain naturally occurring asbestos.

Seven soil types are found in the Dubakella sub-watershed: fine loams, granitic soils, serpentine soils, metamorphic soils, brushy metamorphic soils, shallow metamorphic soils, and alluvial floodplain soils (Appendix C). Two of these types (brushy metamorphic and alluvial floodplain) do not occur within the proposed project area. Fine loams are formed from weathered basalt and metasediments and consist of deep well drained clay loams; they are highly productive on slopes up to 60 percent. Granitic soils are derived from weathered granite and consist of shallow to moderately deep sandy loams that are well drained; they are moderately productive on slopes of 40 to 60 percent. Metamorphic soils are formed from metavolcanic and metasedimentary rocks and are shallow to moderately deep well drained gravelly

loams; they are moderately productive on slopes up to 60 percent. Serpentine soils consist of shallow to moderately deep gravelly clay loams to clays; they are moderately drained on slopes up to 80 percent, and are non-productive to moderately productive depending on the amount of serpentization.

Designated beneficial uses of water in the Dubakella sub-watershed include: municipal, domestic, agricultural and industrial supply; groundwater recharge and freshwater replenishment; navigation; hydropower generation; water contact recreation, and non-contact water recreation; commercial and sport fishing; cold freshwater habitat; wildlife habitat; rare, threatened, or endangered species; migration of aquatic organisms; and spawning, reproduction, and/or early development (Cal. EPA, Regional Water Board, 2011). Aquaculture is a potential future beneficial use.

Pollutants in the Dubakella sub-watershed include sediment and temperature (Cal. EPA, Regional Water Board. 2017). Increased stream temperatures and accelerated sedimentation rates impact the migration, spawning, reproduction, and early development of cold water fish. The impairment has resulted in non-attainment of designated beneficial uses – specifically commercial and sport fishing; cold freshwater habitat; rare, threatened, and endangered species; migration of aquatic organisms; and spawning, reproduction, and/or early development.

Sources of the increased sediment rate in the Dubakella sub-watershed are primarily from roads (U.S. EPA, 1998). Primary causes of road produced sediment include unauthorized roads, unneeded system roads that aren't maintained, undersized culverts that aren't designed to pass 100-year flood peak flows and debris, stream crossings with diversion potential, and roads that aren't hydrologically disconnected from streams.

Water temperatures in the lower South Fork and some of its tributaries, particularly Lower Hayfork Creek downstream of the project area, are too high to fully support aquatic habitat (U.S. EPA, 1998). High temperatures could result from natural conditions[18], water diversions, loss of riparian vegetation, and excess sedimentation that results in channel widening and decreased water depths.

Active Landslides and Inner Gorges

Inner gorges are present in about 6 acres of the proposed project area. The inner gorges are located on Wilson Creek, Goods Creek, West Fork Hayfork Creek, and Dubakella Creek (Appendix A). These inner gorges lie within the Rattlesnake Creek Terrane and the Western Hayfork Terrane.

One active landslide is present in the sub-watershed, and about 80 square feet of the proposed project area lies within this landslide. It is located in the Rattlesnake Creek Terrane in the Headwaters Hayfork Creek drainage (Appendix A).

Naturally-Occurring Asbestos

Naturally-occurring asbestos is a term used for several types of fibrous minerals found in many parts of California (California Environmental Protection Agency, 2002a; USDA FS Pacific Southwest Region, 2008). All types of asbestos are hazardous and may cause lung disease and cancer. The most common type of asbestos is chrysotile, but other types are also found in California. Serpentine often contains chrysotile asbestos. Asbestos is released from serpentine and ultramafic rock when it is broken or crushed. This can happen when land is disturbed that contains these rocks. It is also released naturally through weathering and erosion. Once released from the rock, asbestos can become airborne and may stay in the air for long periods of time.

[18] Water temperatures in the lower South Fork have always been relatively warm in the summer, even prior to active land management in the sub-basin.

Ultramafic rock occurs within the project area (about 32 acres) which could contain naturally-occurring asbestos (Appendix B). The ultramafic rock bodies are found spread throughout the Rattlesnake Creek Terrane.

Soil Stability and Erosion Risk

Erosion risk in the project area ranges from low to moderate. Soils with low risk of erosion include fine loams, metamorphics, and serpentines. Soils with moderate risk of erosion include granitics and shallow metamorphics. There are no soils in the project area with a high or very high risk of erosion.

There are adequate levels of soil cover present in the proposed project area. The soil cover level far exceeds 50%. There are no signs of erosion. The overall existing condition for soil stability in the project area is good.

Surface Organic Matter

Surface organic matter (litter, duff, and course woody debris) varies throughout the project area. Litter and duff ranges from 4 to 6 inches thick, with the deeper duff being directly under trees. Throughout the project area, the size and amount of litter and duff are within the range of the ecological type and normal fire return interval. The amount of coarse woody debris is deficient due to previous logging that removed most of the available coarse wood; however, there is recruitment potential due to standing logs that will soon be downed due to mortality. Due to the coarse woody debris deficiency, the current condition for surface organic matter in the proposed project area is fair.

Soil Organic Matter and Risk of SOM Loss

Most soils in the project area have a low risk of SOM loss due to textures and cohesion. Shallow metamorphics have a moderate risk of SOM loss, and granitics have a very high risk of SOM loss due to shallow depth and textures. The current condition for soil organic matter is good due to limited topsoil displacement in the proposed project area.

Compaction Risk

The LTSP study is an ongoing nation-wide experimental study that helps validate and refine soil resource indicators. Causes of declines in soil productivity have commonly been compaction and/or loss of organic matter, according to findings of the LTSP study.

Compaction studies have shown that soils with rock fragments greater than 40 percent act as a matrix or skeleton that resists compressive forces (Gomez and others, 2002; Liechty and others, 2002).

Compaction risk in the project area ranges from low to high. Metamorphics have a low compaction risk. Soils with a moderate risk of compaction include granitics, shallow metamorphics, and serpentines. Fine loams have a high risk of compaction due to textures, clay content, and lack of rock fragments.

The current condition for soil strength is good. Over most of the project area, the soil strength level is favorable for rooted species.

The current condition for soil structure and macro-porosity is good. Over most of the project area, soil structure and macro-porosity are visually relatively unchanged from the natural condition; signs of erosion or overland flow are absent or very limited in degree and extent; and infiltration and permeability capacity of the soil is sufficient.

Sediment

The current equivalent roaded area is shown in Table 2 for each of the hydrologic units in the project area. No hydrologic units are over the threshold of concern. Dubakella Creek sub-watershed has a low disturbance level. Each of the drainages have a low disturbance level except for Halls City Creek-Wilson Creek, which is moderate. The disturbance level of one of the sub-drainages (1801021203010304) in Stringbean Creek-Goods Creek is moderate, and the disturbance level of two sub-drainages (1801021203010401 of and 1801021203010403) in Halls City Creek-Wilson Creek are moderate.

Table 2. Existing condition ERA in 2019 for the hydrologic units in the project area.

Hydrologic Unit				ERA (Acres)	Risk Ratio (% of TOC)	Disturbance Level
5	6	7	8			
Upper Hayfork Creek				6327	34	Low
	Dubakella Creek			1614	28	Low
		Headwaters Hayfork Creek		224	21	Low
			1801021203010101	78	20	Low
			1801021203010102	75	25	Low
			1801021203010103	71	18	Low
		Dubakella Creek		123	18	Low
			1801021203010201	52	17	Low
			1801021203010202	71	20	Low
		Stringbean Creek-Goods Creek		436	34	Low
			1801021203010301	42	24	Low
			1801021203010302	13	8	Low
			1801021203010303	56	23	Low
			1801021203010304	225	76	Moderate
			1801021203010305	114	28	Low
		Halls City Creek-Wilson Creek		473	50	Moderate
			1801021203010401	201	54	Moderate
			1801021203010402	89	32	Low
			1801021203010403	210	72	Moderate
		Chanchelulla Gulch-Shiell Gulch		336	27	Low
			1801021203010501	91	26	Low
			1801021203010502	94	33	Low

Temperature and Stream Shading

Summer maximum temperatures needed to attain beneficial uses are identified by the U.S. EPA and the Regional Water Board (U.S. EPA, 2003; Carter, 2008). For streams that are used almost exclusively for migration during the period of summer maximum temperatures, a MWMT of 20 ºC is recommended. For adult salmonid migration and non-core[19] juvenile rearing, the MWMT should not exceed 18 ºC. For core juvenile rearing, the MWMT should not exceed 16 ºC.

Stream temperatures in the Dubakella sub-watershed range from less than 16 °C up to 25 °C (Asarian, 2016). Stream temperatures are cold (mean MWMT less than 16 °C) in Chanchelulla Gulch, the headwaters of Dubakella Creek, and in West Fork Hayfork Creek. Streams with temperatures between 16 °C and 18 °C include Wilson Creek, Hall City Creek, Goods Creek, and the mouth of Dubakella Creek. Shiell Gulch has stream temperatures between 18 °C and 20 °C. Mean stream temperatures recorded on

[19] Non-core juvenile rearing is defined as moderate to low density salmon and trout rearing usually occurring in the mid or lower part of the basin. Core rearing areas are defined as areas with moderate to high densities of summertime salmonid juvenile rearing, and are generally found in the mid- to upper portions of river basins.

Hayfork Creek are warmer than its tributaries, ranging from 20 °C to 22 °C between Dubakella Creek and String Bean Creek, and from 22 °C to 25 °C between String Bean Creek and East Fork Hayfork Creek.

Stream shading at reference sites has averaged about 75 percent between 2000 and 2018, with the lowest recorded value of 21 percent at Swift Creek in 2016, and the highest recorded value of 95 percent at Panther Creek in 2016.

Stream shading data has been collected recently at three stream reaches in the Dubakella sub-watershed. In Dubakella Creek, the average stream shading was 88 percent in 2013. In Hayfork Creek, the average stream shading is about 78 percent in 2019, and in South Fork Goods Creek, the average stream shading is about 86 percent in 2019 (Rebecca Pickle, Forest Service Hydrologic Technician, written communication). All three of these sites have an above average amount of shading compared to reference stream reaches.

LWD in Streams

LWD plays an important role in channel morphology by forming pools, by storing sediment, and by increasing hydraulic complexity (Cal. EPA, Regional Water Board, 2006). LWD plays different roles in different sized streams. In steep headwater streams for example, LWD creates a stepped longitudinal profile that governs the storage and release of sediment. LWD is also important in the floodplain, where it can meter sediment, and stabilize stream banks. The mean diameter and length of LWD increases and the frequency of LWD decreases as stream channel width increases. In other words, as channels become wider, LWD pieces become larger but are found in fewer numbers due to the increasing capacity of the stream to transport LWD.

In Dubakella Creek, there were about 122 pieces of LWD per mile of stream in 2013 (USDA Forest Service, Shasta-Trinity National Forest, 2013). Compared to reference stream reaches, this is a deficiency of roughly 90 pieces per mile. In 2019, LWD ranges from 5 inches to 30 inches in diameter in Dubakella Creek; the average diameter is 15 ± 6 inches (Rebecca Pickle, Forest Service Hydrologic Technician, written communication).

In Hayfork Creek in 2019, there are about 164 pieces of LWD per mile of stream; the diameter of LWD ranges from 5 to 34 inches and the average is 13 ± 8 inches (Rebecca Pickle, Forest Service Hydrologic Technician, written communication). Compared to references stream reaches, this is a deficiency of about 70 pieces per mile.

In South Fork Goods Creek in 2019, there are about 137 pieces of LWD per mile of stream; the diameter of LWD ranges from 5 to 22 inches and the average is 7 ± 4 inches (Rebecca Pickle, Forest Service Hydrologic Technician, written communication). Compared to reference stream reaches, this is a deficiency of more than 200 pieces per mile.

For all three of the surveyed streams in the project area, there are sufficient quantities of LWD smaller than about ten inches in diameter, and deficiencies of LWD larger than about ten inches in diameter.

Environmental Consequences of the Proposed Action

Project Design Features and Mitigation Measures

Best Management Practices

BMPs are designed to protect water quality and are taken from the Forest Service national BMPs technical guide (USDA Forest Service, 2012). Activities for which BMPs are required for this project

include mechanical vegetation management activities, fire management activities, and road management activities.

Legacy Sediment Sites

Legacy sediment sites that have been identified within the project area will be treated in compliance with Forest Service and Regional Water Board direction to mitigate the impacts of project activities. The treatments for all legacy sediment sites are described in Appendix D.

General BMPs that apply to all Project Activities

Riparian Reserves Planning

- Riparian Reserves in the project area are specified by category as follows:
  - Fish-bearing streams. The stream and the area from the edge of the active stream channel to the top of the inner gorge, or a distance equal to the height of 2 site potential trees on each side of the channel, or a distance of 300 feet on each side of the channel, whichever is greatest.
  - Perennial nonfish-bearing streams. The stream and the area from the edge of the active stream channel to the top of the inner gorge, or a distance equal to the height of 1 site potential tree on each side of the channel, or a distance of 150 feet on either side of the channel, whichever is greatest.
  - Intermittent streams. The stream channel and the area from the edge of the channel to the top of the inner gorge, or a distance equal to the height of 1 site potential tree, or a distance of 100 feet on each side of the channel, whichever is greatest.
  - Lakes. The body of water and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest.
  - Active landslide areas. The extent of the unstable or potentially unstable area.
- An equipment exclusion zone (EEZ) will be utilized within the Riparian Reserves to:
  - Avoid unacceptable impacts to riparian vegetation, groundwater recharge areas, steep slopes, highly erodible soils, or unstable areas.
  - Maintain or provide sufficient ground cover to encourage infiltration, avoid erosion, and to filter pollutants.
  - Avoid detrimental soil compaction.
  - Retain trees necessary for shading, bank stabilization, and as a future source of large woody debris.
  - Retain floodplain function.
- EEZs in the project area are specified by category as follows:
  - Perennial streams. The stream and the area from the edge of the active stream channel to the top of the inner gorge, or a distance of 150 feet on each side of the channel, whichever is greatest.
  - Intermittent streams. The stream channel and the area from the edge of the channel to the top of the inner gorge, or a distance of 50 feet on each side of the channel, whichever is greatest. Areas within Riparian Reserves with slopes greater than 35 percent, highly erodible soils, or high soil compaction risk are also included in the EEZ.
  - Lakes. The body of water and 150 feet slope distance.
  - Active landslide areas. The entire extent of the unstable or potentially unstable area.
- Inner gorges and active landslide areas are lands unsuitable for timber production.

- Mark the boundaries of the Riparian Reserves and EEZs on the ground before land disturbing activities.
  - Any changes to the boundaries of inner gorges and active landslide areas have to be approved by the geologist before ground-disturbing activities.

Mechanical Vegetation Management Activities

Erosion Prevention and Control

- Establish designated areas for equipment staging and parking to minimize the area of ground disturbance.
- Use provisions in the timber sale contract to implement and enforce erosion control on the project area. Locate landings, skid trails, and slash piles in suitable sites to avoid, minimize, or mitigate potential for erosion and sediment delivery to nearby waterbodies.
- Develop an erosion control and sediment plan that covers all disturbed areas including skid trails and roads, landings, cable corridors, temporary road fills, water source sites, borrow sites, or other areas disturbed during mechanical vegetation treatments.
- Project design features and mitigation measures for effective erosion control include:
  - Dedicate no more than 15 percent of a thinning unit to primary skid trails and landings.
  - Re-use existing primary skid trails and landings whenever possible.
  - Avoid soil displacement to the extent practicable. Do not blade topsoil from skid trails and landings.
  - Skid-trails, when possible, will be located on ridge tops, flat benches, or existing skid trails will be re-used to minimize soil displacement and enhance drainage. When not possible, additional mitigation (subsoiling) may be required.
  - Install waterbars at major breaks in slope along skid-trails.
  - Apply mulch to the last 50 feet of main skid trails where they enter landings or roads. Mulch should achieve at least 75 percent cover.
  - Skid-trails that intersect Forest System roads will be blocked with available material (large wood or boulders).
- Install sediment and stormwater controls before initiating surface-disturbing activities to the extent practicable.
- Operate equipment when soil compaction, displacement, erosion, and sediment runoff would be minimized.
  - Avoid ground equipment operations on unstable, wet, or easily compacted soils and on steep slopes unless operation can be conducted without causing excessive rutting, soil puddling, or runoff of sediments directly into waterbodies.
  - Evaluate site conditions frequently to assess changing conditions.
  - Adjust equipment operations as necessary to protect the site while maintaining efficient project operations.
- Install suitable stormwater and erosion control measures to stabilize disturbed areas and waterways on incomplete projects before seasonal shutdown of operations or when severe storm or cumulative precipitation events that could result in sediment mobilization to waterbodies are expected.
- Routinely inspect disturbed areas to verify that erosion and stormwater controls are implemented and functioning as designed and are suitably maintained.
- Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning. Prepare for unexpected failures of erosion control measures.
- Implement mechanical treatments on the contour of sloping ground to avoid or minimize water concentration and subsequent accelerated erosion.

Riparian Reserves

- Clearly delineate Riparian Reserve boundaries in the project area using suitable markings and structures.
  - Maintain or reestablish these boundaries as necessary during project implementation or operation.
  - Specify Riparian Reserve layout, maintenance, and operating requirements in contracts, design plans, and other necessary project documentation.
- Use mechanical vegetation treatments in Riparian Reserves only when suitable to achieve long-term Riparian Reserve desired conditions and management objectives.
  - Inner gorges and active landslide areas are unsuitable for mechanical vegetation treatments without irreversible damage to soils productivity or watershed condition.
- Modify mechanical vegetation treatment prescriptions and operations in the Riparian Reserves as needed to maintain ecosystem structure, function, and processes.
  - Design silvicultural or other vegetation management prescriptions to maintain or improve the riparian ecosystem and adjacent waterbody.
  - Use yarding systems or mechanical treatments that avoid or minimize disturbance to the ground and vegetation consistent with project objectives.
  - Conduct equipment operations in a manner that maintains or provides sufficient ground cover to meet land management plan desired conditions, goals, and objectives to minimize erosion and trap sediment.
  - Use suitable measures to avoid or minimize soil disturbance from equipment operations to stay within acceptable disturbance levels when conducting mechanical vegetation treatment operations.
  - Prescribe mechanical site preparation techniques and fuels and residual vegetation treatments that avoid or minimize excessive erosion, sediment delivery to nearby waterbodies, or damage to desired riparian vegetation.
  - Conduct operations in a manner that avoids or minimizes introduction of excess slash or other vegetative debris into the Riparian Reserves and waterbodies; damage to streambanks, shorelines, and edges of wetlands; and adverse effects to floodplain functioning.
  - Retain trees as necessary for canopy cover and shading, bank stabilization, and as a source of large woody debris within the Riparian Reserves.
    - Any trees greater than 10 inches in diameter felled within the EEZ of perennial streams will be left in place.
  - Avoid felling trees into streams or waterbodies, except as planned to create habitat features.
    - Trees greater than 10 inches in diameter that are felled within the EEZ of perennial streams will be felled towards the stream when possible.
    - There will be no removal of downed large woody debris from watercourse channels unless the debris is causing a safety hazard.
- Locate transportation facilities for mechanical vegetation treatments, including roads, landings, and main skid trails, outside of Riparian Reserves to the extent practicable.
  - Minimize the number of stream crossings to the extent practicable.
  - Evaluate options for routes that must cross waterbodies and choose the one (e.g., specified road vs. temporary road vs. skid road or trail) that avoids or minimizes adverse effects to soil, water quality, and riparian resources to the greatest extent practicable.
  - Do not use drainage bottoms as turn-around areas for equipment during mechanical vegetation treatments.

- Use suitable measures to disperse concentrated flows of water from road surface drainage features to avoid or minimize surface erosion, gully formation, and mass failure in the Riparian Reserve and sediment transport to the waterbody.
- Monitor Riparian Reserves during mechanical operations to evaluate compliance with prescription and mitigation requirements in the authorizing document.
  - Adjust operations to avoid, minimize, or mitigate detrimental soil impacts where they are occurring.
  - Use suitable mitigation or restoration measures on areas that show signs of unacceptable erosion, or those with high potential for erosion due to mechanical operations.
  - Remove unauthorized debris from waterbodies using techniques that will limit disturbance to bed and banks, riparian areas, aquatic-dependent species, and the waterbody unless significant damage would occur during its removal or leaving it in meets desired conditions for the waterbody.

Ground-based Skidding and Yarding Operations

- Use ground-based yarding systems only where physical site characteristics are suitable to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
  - Mechanical skidding equipment is generally restricted to slopes less than 35 percent. On short steep pitches (greater than 35 percent slope, less than 45 percent slope, and less than 100 feet in length), mechanical skidding equipment is restricted to slash covered primary skid trails using flexible track skidders with low ground pressure equipment.
  - Inner gorges and active landslide areas are unsuitable for ground-based yarding systems without irreversible damage to soils productivity or watershed condition.
- Use existing roads and skid trail networks to the extent practicable. Create new roads and skid trails where re-use of existing ones would exacerbate soil, water quality, and riparian resource impacts.
- Design and locate skid trails and skidding operations to minimize soil disturbance to the extent practicable.
  - Designate skid trails to the extent practicable to limit site disturbance.
  - Locate skid trails outside of active landslides and inner gorges. No existing skid trails on active landslides or within inner gorges will be used.
  - Locate skid trails outside of Riparian Reserves to the extent practicable.
    - No full bench skid trails will be constructed within Riparian Reserves.
  - Locate skid trails to avoid concentrating runoff and provide breaks in grade.
  - Limit the grade of constructed skid trails on geologically potentially unstable, saturated, highly erodible, or easily compacted soils.
  - Avoid long runs on steep slopes.
- Use suitable measures during felling and skidding operations to avoid or minimize disturbance to soils and waterbodies to the extent practicable.
  - Perform skidding or yarding operations when soil conditions are such that soil compaction, displacement, and erosion would be minimized.
  - Suspend skidding or yarding operations when soil moisture levels could result in unacceptable soil damage.
  - Avoid skidding logs in or adjacent to a stream channel or other waterbody to the extent practicable.
    - Any proposed intermittent and perennial stream temporary crossings will be reviewed in the field and approved for use by a physical scientist prior to use.
  - Skid across streams only at designated locations.

  - Use suitable measures at skid trail crossings to avoid or minimize damage to the stream channel and streambanks.
    - During construction of temporary stream crossings, disturbance to existing live vegetation will be minimized to the maximum extent possible.
    - Nonfish-bearing stream crossings will be rocked.
    - Fish-bearing stream crossings will be constructed to maintain fish passage and will be reshaped and stabilized following use. When a crossing is rehabilitated, the fill will be pulled back so that the original stream level is re-established and the culvert will be removed.
    - If intermittent stream crossings are left in place for wet weather operations, they will be removed during the following dry season.
  - Directionally fell trees to facilitate efficient removal along predetermined yarding patterns with the least number of passes and least amount of disturbed area (e.g., felling-to-the-lead).
  - Directionally fell trees away from streambanks, shorelines, and other waterbody edges.
  - Winch or skid logs upslope, away from waterbodies.
  - Use low ground pressure equipment when practicable, particularly on equipment traveling over large portions of units with sensitive soils or site conditions.
- Use suitable measures to stabilize and restore skid trails after use.
  - Reshape the surface to promote dispersed drainage.
  - Install suitable drainage features.
  - Mitigate soil compaction to improve infiltration and revegetation conditions.
  - Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion before the next growing season.
  - Use suitable measures to promote rapid revegetation.

Cable and Aerial Yarding Operations

- Use cable or aerial yarding systems on steep slopes where ground-based equipment cannot operate without causing unacceptable ground disturbance.
  - Inner gorges and active landslide areas are unsuitable for cable or aerial yarding systems without irreversible damage to soils productivity or watershed condition.
  - Consider slope shape, potential barriers, lift and deflection requirements, and availability of suitable landing locations when selecting cable-yarding systems.
- Identify areas requiring cable or aerial yarding during project planning and in the contract.
- Identify necessary equipment capabilities in the contract.
- Locate cable corridors to efficiently yard materials with the least soil damage.
  - Use suitable measures to minimize soil disturbance when yarding over breaks in slope.
- Fully suspend logs to the extent practicable when yarding over Riparian Reserves and streams.
- Postpone yarding operations when soil moisture levels are high if the specific type of yarding system results in unacceptable soil disturbance and erosion within cable corridors.

Landings

- Minimize the size and number of landings as practicable to accommodate safe, economical, and efficient operations.
- Locate landings to limit the potential for pollutant delivery to waterbodies.
  - Locate landings outside of Riparian Reserves and as far from waterbodies as reasonably practicable based on travel routes and environmental considerations.
    - No new landings will be constructed within Riparian Reserves.

  - Avoid locating landings near any type of likely flow or sediment transport conduit during storms, such as ephemeral channels and swales, where practicable.
  - Locate landings to minimize the number of required skid roads.
  - Avoid locating landings on steep slopes (greater than 25 percent gradient) or highly erodible soils where practicable.
  - Avoid placing landings where skidding across drainage bottoms is required.
- Design roads and trail approaches to minimize overland flow entering the landing.
- Re-use existing landings where their location is compatible with management objectives and water quality protection.
  - Existing landings within the Riparian Reserve can be re-used provided they are outside the EEZ; however, the area of disturbance will not be increased and these features will be tilled and seeded following use where they do not need to be retained as part of the road system.
- All new landing fill slopes and access road fill slopes should be mulched initially, and the mulch should be maintained throughout the life of the project. Mulch may be weed-free straw, rice, or landing slash.
- Use applicable practices when managing fuels, chemicals, or other hazardous materials on the landing.
  - Plan for suitable equipment refueling and servicing sites during project design. Allow temporary refueling and servicing only at approved locations, located well away from Riparian Reserves, groundwater recharge areas, and waterbodies.
  - Limit the storage and use of hazardous materials to only those necessary and consistent with project requirements.
  - Prepare a certified Spill Prevention Control and Countermeasure (SPCC) Plan. Ensure that cleanup of spills are completed in compliance with Federal, State, and local regulations and requirements.
  - Ensure that hazardous spill kits are adequately stocked with necessary supplies and are maintained in accessible locations.
  - Use suitable measures around vehicle service, storage and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills and avoid or minimize soil contamination and seepage to groundwater.
  - Provide training for all personnel handling fuels and chemicals in their proper use, handling, storage, and disposal.
- Use suitable measures as needed to restore and stabilize landings after use.
  - Remove all logging machinery refuse (e.g., tires, chains, chokers, cable, and miscellaneous discarded parts) and contaminated soil to a proper disposal site.
  - Reshape the surface to promote dispersed drainage.
  - Install suitable drainage features.
  - Mitigate soil compaction to improve infiltration and revegetation conditions.
    - Rip (subsoil to 18 inches) all landings on fine-textured non-rocky soils with a winged-subsoiler.
  - Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion before the next growing season.
    - For landings that are to be rehabilitated, use straw mulch or available slash to achieve 2 tons per acre of cover (4 to 6 inches).
    - For landings that are to be retained, use straw or available organic material to achieve 1 ton per acre of cover (2 to 4 inches).and seed with native grass at a rate of 6 to 10 lbs/acre.
  - Use suitable measures to promote rapid revegetation.

- For landings that are to be retained, seed with native grass at a rate of 6 to 10 pounds per acre.

Mechanical Site Treatment

- Evaluate multiple site factors, including soil conditions, slope, topography, and weather, to prescribe the most suitable mechanical treatment and equipment to avoid or minimize unacceptable impacts to soil while achieving treatment objectives.
  - Ground-based mechanical equipment will only operate on fine-textured soils (non-rocky) when the soils are dry down to 8 inches (designee trained by forest soil scientist).
  - Wet weather logging is permitted on soils with compaction hazard ratings of moderate or less with the following restrictions:
    - Subsoil landings, haul roads and main skid-trails after use.
  - Shallow soils are susceptible to detrimental soil disturbance and should only be operated on when dry and on slopes less than 35 percent. The following must be used:
    - Keep skidders (rubber tired or fixed track) on slopes less than 35 percent.
    - A feller buncher can pack smaller trees off of short steep pitches. Coordinate with soil scientist on layout and favorable soil conditions. Use flexible track (low ground disturbance) skidders with minimal turning.
    - Displaced topsoil (typically 2 to 4 inches thick) should not have an aerial extent of more than about 15 feet by 15 feet (or about 225 square feet).
  - Retained LWD should be at least 5 logs per acre in contact with the soil surface. Desired logs are about 20 inches in diameter, about 10 feet long and represent the range of decomposition classes. Attempt to protect logs in decomposition classes 3 through 5 from burning and mechanical disturbance.
  - Ground-based mastication operations on fine-textured soils (clay loams, clays, silty clay loams) should operate when:
    - Soil moisture is sufficiently dry to a depth of 8 inches (less than 30 percent by weight evaluated by forest soil scientist or trained designee) for use of low ground pressure equipment (less than 6psi) on slopes less than 35 percent.
    - Drive over masticated material to form a cushion to reduce displacement and compaction.
    - For equipment with ground pressure over 6 psi, operations will be conducted when the soils are dry (less than 18 percent moisture by weight) to a depth of 8 inches on slopes up to 35 percent.
    - Soil moisture operability will be evaluated in the field by the forest soil scientist or an inspector trained by the forest soil scientist).
  - Post-treatment total soil cover should be between 50 and 70 percent on metamorphic soils (at least half the cover should be fine organic matter such as duff, litter, plant leaves/needles, and fine slash less than 3 inches in length), and greater than 90 percent on granitic soils (at least half the cover should be fine organic matter such as duff, plant leaves/needles, and fine slash less than 3 inches in length).
- Operate mechanical equipment so that furrows and soil indentations are aligned on the contour.
- Scarify the soil only to the extent necessary to meet reforestation objectives.
  - Use site-preparation equipment that produces irregular surfaces.
  - Avoid or minimize damage to surface soil horizons to the extent practicable.
- Conduct machine piling of slash in such a manner to leave topsoil in place and to avoid displacing soil into piles.
- Re-establish vegetation as quickly as possible.
  - Evaluate the need for active and natural revegetation of exposed and disturbed sites.

- Use suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

Fire Management Activities

- Conduct the prescribed fire in such a manner as to achieve the burn objectives outlined in the Burn Plan.
- Locate access and staging areas near the project site but outside of Riparian Reserves, wetlands, and sensitive soil areas.
  - Keep staging areas as small as possible while allowing for safe and efficient operations.
  - Store fuel for ignition devices outside of Riparian Reserves.
  - Install suitable measures to minimize and control concentrated water flow and sediment from staging areas.
  - Collect and properly dispose of trash and other solid waste.
  - Restore and stabilize staging areas after use.
- Conduct prescribed fires to minimize the residence time on the soil while meeting the burn objectives. Manage fire intensity to maintain target levels of soil temperature and duff and residual vegetative cover within the limits and at locations described in the prescribed fire plan.
- Construct fireline to the minimum size and standard necessary to contain the prescribed fire and meet overall project objectives.
  - Locate and construct fireline in a manner that minimizes erosion and runoff from directly entering waterbodies by considering site slope and soil conditions, and using and maintaining suitable water and erosion control measures.
  - Consider alternatives to ground-disturbing fireline construction such as using wet lines, rock outcrops, or other suitable features for firelines.
  - Maintain firebreaks in a manner that minimizes exposed soil to the extent practicable.
  - Rehabilitate or otherwise stabilize fireline in areas that pose a risk to water quality.
- Alter prescribed fire prescriptions and control actions in the Riparian Reserves as needed to maintain ecosystem structure, function, and processes and onsite and downstream water quality.
  - Any trees greater than 10 inches in diameter felled within the EEZ of perennial streams will be left in place. Activity fuels that remain after meeting wildlife, riparian, soil, and other environmental needs will be considered surplus and a potential fire hazard. The amount and method of disposal will be determined in consultation with a fish biologist and/or hydrologist.
    - An exception is allowed where a road runs parallel to a perennial stream within the EEZ. Trees uphill of the road may be removed. However, equipment used to remove trees will remain on the existing roadbed.
  - Pretreat Riparian Reserves and drainage ways to reduce excessive fuel loadings.
  - Avoid building firelines in or around riparian areas, wetlands, marshes, bogs, fens, or other sensitive water-dependent sites unless needed to protect life, property, or wetlands.
  - Construct any essential fireline in the Riparian Reserve in a manner that minimizes the amount of area and soil disturbed.
  - Keep high-intensity fire out of Riparian Reserves unless suitable measures are used to avoid or minimize adverse effects to water quality.
  - Avoid or minimize complete removal of the organic layer when burning in riparian areas or wetlands to maintain soil productivity, infiltration capacity, and nutrient retention.
  - Rehabilitate fireline in the Riparian Reserve after prescribed fire treatment is completed.
  - Remove debris added to stream channels as a result of the prescribed burning unless debris is prescribed to improve fisheries habitat.

- Stream shading will not be reduced at any time by more than 10 percent below pre-project levels.
- Treatments in active landslide areas will be phased to reach the desired condition.

♦ Conduct prescribed fire treatments, including pile burning, for slash disposal in a manner that encourages efficient burning to minimize soil impacts while achieving treatment objectives.
- Pile and burn only the slash that is necessary to be disposed of to achieve treatment objectives. Machine piling should retain greater than 50 percent of the existing surface litter and duff.
- Locate slash piles in areas where the potential for soil effects is lessened (meadows, rock outcrops, etc.) and that do not interfere with natural drainage patterns.
- Minimize the amount of dirt or other noncombustible material in slash piles to promote efficient burning.
- Construct piles in such a manner as to promote efficient burning.
- Avoid burning large stumps and sections of logs in slash piles to reduce the amount of time that the pile burns.
- Avoid burning when conditions will cause the fire to burn too hot and damage soil conditions.
- Avoid piling and burning for slash removal in Riparian Reserves to the extent practicable.
  - Hand piling and pile burning will not occur within 50 feet of streams.
  - Hand piling and pile burning is allowed in active landslide areas.
- Machine piling on fine-textured soils should occur only on dry soils (generally less than 18% soil moisture) with less than 35 percent slopes.
- Avoid machine piling or masticating on slopes greater than 35 percent. Use hand piling or lopping and scattering on slopes greater than 35 percent.
- Pile sizes will be limited to about 10 feet in height and about 30 feet in width with a mix of woody debris sizes.
- Post-treatment total soil cover should be between 50 and 70 percent on metamorphic soils (with at least 50 percent cover in a mosaic pattern as fine organic matter such as duff, plant leaves/needles, and fine slash less than 3 inches in length), and greater than 90 percent (with at least 50 percent cover as fine organic matter such as duff, plant leaves/needles, and fine slash less than 3 inches in length) on granitic soils.
- Retain existing down coarse woody debris whenever possible providing the amount of logs does not exceed fuel management objectives. At least 5 logs/acre should be retained with 4 to 8 tons/acre of fuel remaining for protection of soil fertility with preferred decay classes 3 to 5. Desired logs are at least 20 inches in diameter and 10 feet long. Fine organic matter and large woody material together should amount to less than about 6 tons per acre dry weight to alleviate the risk of potential detrimental wildfire effects. Other surface organic matter (3 inches to 20 inches in diameter), or amounts of fine organic matter and large woody material in excess of amounts described in detail above need not be retained.
- Hand lines should be water barred and covered with organic material following prescribed burns. Soils that have greater than 35 percent rock fragments are not required to be covered.
- For granitic soils, low intensity broadcast burning is recommended. For all other soils, a mosaic of low and moderate burn severity is acceptable when recruitment opportunities exist.

♦ Evaluate the completed burn to identify sites that may need stabilization treatments or monitoring to minimize soil and site productivity loss and deterioration of water quality both on and off the site.
- Provide for rapid revegetation of all denuded areas through natural processes supplemented by artificial revegetation where necessary.

- Use suitable measures to promote water retention and infiltration or to augment soil cover where necessary.
- Clear streams and ditches of debris introduced by fire control equipment during the prescribed fire operation.
- Consider long-term management of the site and nearby areas to promote project success.
- Use suitable measures to limit human, vehicle, and livestock access to site as needed to allow for recovery of vegetation.

Road Management Activities

Road Reconstruction

- Use applicable practices for stormwater management and erosion control when reconstructing system roads.
  - Establish designated areas for equipment staging, stockpiling materials, and parking to minimize the area of ground disturbance.
  - Establish and maintain construction area limits to the minimum area necessary for completing the project and confine disturbance to within this area.
  - Develop and implement an erosion control and sediment plan that covers all disturbed areas, including borrow, stockpile, fueling, and staging areas used during construction activities.
  - Calculate the expected runoff generated using a suitable design storm to determine necessary stormwater drainage capacity.
  - Install sediment and stormwater controls before initiating surface-disturbing activities to the extent practicable.
  - Schedule, to the extent practicable, construction activities to avoid direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely to occur. Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction operations. Limit operation of equipment when ground conditions could result in excessive rutting, soil puddling, or runoff of sediments directly into waterbodies.
  - Install suitable stormwater and erosion control measures to stabilize disturbed areas and waterways before seasonal shutdown of project operations or when severe or successive storms are expected.
  - Use low-impact development practices where practicable.
  - Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning. Prepare for unexpected failures of erosion control measures. Implement corrective actions without delay when failures are discovered to prevent pollutant discharge to nearby waterbodies.
  - Routinely inspect construction sites to verify that erosion and stormwater controls are implemented and functioning as designed and are appropriately maintained.
- Identify and locate waste areas before the start of operations.
  - Deposit and stabilize excess and unsuitable materials only in designated sites.
  - Do not place such materials on slopes with a risk of excessive erosion, sediment delivery to waterbodies, mass failure, or within the Riparian Reserve.
  - Provide adequate surface drainage and erosion protection at disposal sites.
- Avoid or minimize excavated materials from entering waterbodies.
- Remove slash and cull logs to designated sites outside the Riparian Reserve for storage or disposal. Consider using cull logs in aquatic ecosystem projects to achieve aquatic resource management objectives as opportunities arise.

Road Operations and Maintenance

- Develop and implement road maintenance plans for projects where contractors or permittees are responsible for maintenance activities. Define responsibilities and maintenance timing in the plan.
- Ensure the necessary specifications concerning pre-haul maintenance, maintenance during haul, and post-haul maintenance (putting the road back in storage) are in place when maintenance level 1 roads are opened for use on commercial resource management projects or other permitted activities.
  - Require the commercial operator or responsible party to leave roads in a satisfactory condition when project is completed.
- Inspect roads frequently during operations. Restrict use if road damage such as unacceptable surface displacement or rutting is occurring.
- Remove vegetation from swales, ditches, and shoulders, and cut and fill slopes only when it impedes adequate drainage, vehicle passage, or obstructs necessary sight distance to avoid or minimize unnecessary or excessive vegetation disturbance.
- Maintain road surface treatments to stabilize the roadbed, reduce dust, and control erosion consistent with anticipated traffic and use.
- Maintain the road surface drainage system to intercept, collect, and remove water from the road surface and surrounding slopes in a manner that reduces concentrated flow in ditches, culverts, and over fill slopes and road surfaces.
  - Clean ditches and catch basins only as needed to keep them functioning.
  - Do not undercut the toe of the cut slope when cleaning ditches or catch basins.
  - Use suitable measures to avoid, to the extent practicable, or minimize direct discharges from road drainage structures to nearby waterbodies.
- Maintain road surface treatments to stabilize the roadbed, reduce dust, and control erosion consistent with anticipated traffic and use.
  - All roads within Riparian Reserves shall be surfaced with competent rock to a sufficient depth prior to use of the road to prevent road fines from discharging into watercourses.
- Grade road surfaces only as necessary to meet the smoothness requirements of the assigned operational maintenance level and to provide adequate surface drainage.
  - Do not undercut the toe of the cut slope when grading roads.
  - Do not sidecast maintenance-generated debris within Riparian Reserves to avoid or minimize excavated materials entering waterbodies or riparian areas.
  - Avoid overwidening of roads due to repeated grading over time, especially where sidecast material would encroach on waterbodies.
  - Use potential sidecast or other waste materials on the road surface where practicable.
  - Dispose of unusable waste materials in designated disposal sites.
- Ensure that drainage features are fully functional on completion of operations.
  - Shape road surfaces to drain as designed.
  - Construct or reconstruct drainage control structures as needed.
  - Ensure that ditches and culverts are clean and functioning.
  - Remove berms unless specifically designed for erosion control purposes.

Temporary Roads

- Locate temporary roads to fit the terrain, follow natural contours, and limit the need for excavation.
  - Avoid locations that require extended steep grades, sharp curves, or switchbacks.
- Locate temporary roads on stable geology with well-drained soils and rock formations that dip into the slope.

  - Avoid wetlands, inner gorges, overly steep slopes, and unstable landforms to the extent practicable.
- Locate roads as far from waterbodies as is practicable to achieve access objectives, with a minimum number of crossings and connections between the road and the waterbody.
  - Avoid Riparian Reserves to the extent practicable.
- Install sediment and stormwater controls before initiating surface-disturbing activities to the extent practicable.
- Schedule construction activities to avoid direct soil and water-disturbance during periods of the year when heavy precipitation and runoff are likely to occur.
- Routinely inspect temporary roads to verify that erosion and stormwater controls are implemented, functioning, and appropriately maintained.
- Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning.
  - Temporary roads used during wet weather operations will be spot rocked with aggregate.
- Temporary roads will be returned to pre-existing conditions.
  - Culverts will be pulled.
  - Fill will be pulled back from crossings.
  - Roads will be ripped (sub-soiled to 18 inches), out sloped, and mulched (weed-free rice straw, woodchips, or approved fine slash) to achieve 2 tons per acre of cover. Areas where soils are very rocky or shallow may not require subsoiling but only scarification.
  - Temporary roads on slopes less than 15 percent require little restoration due to minimal soil disturbance and may require only scarification and blockage or any minimal appropriate restoration.

Road Storage

- Implement suitable measures to close and physically block the road entrance so that unauthorized motorized vehicles cannot access the road. Remove the road from the Motor Vehicle Use Map (MVUM) to include the change in the annual forestwide order associated with the MVUM.
- Establish effective ground cover on disturbed sites to avoid or minimize accelerated erosion and soil loss.
- Evaluate all stream and waterbody crossings for potential for failure or diversion of flow if left without treatment.
  - Use suitable measures to reduce the risk of flow diversion onto the road surface.
  - Remove culverts, fill material, and other structures that present an unacceptable risk of failure or diversion.
    - Consider leaving existing crossings in low-risk situations where the culvert is not undersized, does not present an undesired passage barrier to aquatic organisms, and is relatively stable.
  - Reshape the channel and streambanks at the crossing-site to pass expected flows without scouring or ponding, minimize potential for undercutting or slumping of streambanks, and maintain continuation of channel dimensions and longitudinal profile through the crossing site.
  - Use suitable measures to avoid or minimize scour and downcutting.
- Use suitable measures to ensure that the road surface drainage system will intercept, collect, and remove water from the road surface and surrounding slopes in a manner that reduces concentrated flow in ditches, culverts, and over fill slopes and road surfaces without frequent maintenance.

- Use suitable measures to stabilize unstable road segments, seeps, slumps, or cut or fill slopes where evidence of potential failure exists.

Stream Crossings

- Use suitable measures to protect the waterbody when preparing the site for construction or maintenance activities.
  - Clearly delineate the work zone.
  - Locate access and staging areas near the project site but outside of work area boundaries, Riparian Reserves, wetlands, and sensitive soil areas.
  - Refuel and service equipment only in designated staging areas.
  - Develop an erosion and sediment control plan to avoid or minimize downstream impacts using measures appropriate to the site and the proposed activity.
  - Prepare for unexpected failures of erosion control measures.
  - Consider needs for solid waste disposal and worksite sanitation.
  - Consider using small, low ground pressure equipment, and hand labor where practicable.
  - Ensure all equipment operated in or adjacent to the waterbody is clean of aquatic invasive species, as well as oil and grease, and is well maintained.
  - Use vegetable oil or other biodegradable hydraulic oil for heavy equipment hydraulics wherever practicable when operating in or near water.
- Schedule construction or maintenance operations in waterbodies to occur in the least critical periods to avoid or minimize adverse effects to sensitive aquatic and aquatic-dependent species that live in or near the waterbody.
  - Avoid scheduling instream work during the spawning or migration seasons of resident fish and other important life history phases of sensitive species that could be affected by the project.
  - Avoid scheduling instream work during periods that could be interrupted by high flows.
  - Consider the growing season and dormant season for vegetation when scheduling activities within or near the waterbody to minimize the period of time that the land would remain exposed, thereby reducing erosion risks and length of time when aesthetics are poor.
- Use suitable measures to protect the waterbody when clearing the site.
  - Clearly delineate the geographic limits of the area to be cleared.
  - Use suitable drainage measures to improve the workability of wet sites.
  - Avoid or minimize unacceptable damage to existing vegetation, especially plants that are stabilizing the bank of the waterbody.
- Use suitable measures to avoid or minimize impacts to the waterbody when implementing construction and maintenance activities.
  - Minimize heavy equipment entry into or crossing water as is practicable.
  - Conduct operations during dry periods.
  - Stage construction operations as needed to limit the extent of disturbed areas without installed stabilization measures.
  - Promptly install and appropriately maintain erosion control measures.
  - Promptly install and appropriately maintain spill prevention and containment measures. Promptly rehabilitate or stabilize disturbed areas as needed following construction or maintenance activities.
  - Stockpile and protect topsoil for re-use in site revegetation.
  - Minimize bank and riparian area excavation during construction to the extent practicable.
  - Keep excavated materials out of the waterbody.
  - Use only clean, suitable materials that are free of toxins and invasive species for fill.
  - Properly compact fills to avoid or minimize erosion.

  - Balance cuts and fills to minimize disposal needs.
  - Remove all project debris from the waterbody in a manner that will cause the least disturbance.
  - Identify suitable areas offsite or away from waterbodies for disposal sites before beginning operations.
  - Contour site to disperse runoff, minimize erosion, stabilize slopes, and provide a favorable environment for plant growth.
- Use suitable measures to divert or partition channelized flow around the site or to dewater the site as needed to the extent practicable.
  - Remove aquatic organisms from the construction area before dewatering and prevent organisms from returning to the site during construction.
  - Return clean flows to channel or waterbody downstream of the activity.
  - Restore flows to their natural stream course as soon as practicable after construction or before seasonal closures.
- Inspect the work site at suitable regular intervals during and after construction or maintenance activities to check on quality of the work and materials and identify need for mid-project corrections.
- Consider short-term maintenance needs when designing the project. Develop a strategy for providing emergency maintenance when needed.
- Use crossing structures suitable for the site conditions.
- Design and locate crossings to minimize disturbance to the waterbody.
- Use suitable surface drainage and roadway stabilization measures to disconnect the road from the waterbody to avoid or minimize water and sediment from being channeled into surface waters and to dissipate concentrated flows.
- Use suitable measures to avoid, minimize, or mitigate damage to the waterbody and banks when transporting materials across the waterbody or Riparian Reserve during construction activities.
- Design the crossing to pass a normal range of flows for the site.
  - Design the crossing structure to have sufficient capacity to convey the design flow without appreciably altering streamflow characteristics.
  - Install stream crossings to sustain bankfull dimensions of width, depth, and slope and maintain streambed and bank resiliency and continuity through the structure.
- Design road fill to prevent restriction of flood flows.
  - Use site conditions and local requirements to determine design flood flows.
  - Use suitable measures to protect fill from erosion and to avoid or minimize failure of the crossing at flood flows.
  - Use suitable measures to provide floodplain connectivity to the extent practicable.
- Use suitable measures to avoid or minimize scour and erosion of the channel, crossing structure, and foundation to maintain the stability of the channel and banks.
- Consider the use of bottomless arch culverts where appropriate to allow for natural channel migration and desired aquatic organism passage.

Parking and Staging Areas

- Use stormwater management and erosion control practices when maintaining parking or staging areas.
  - Control, collect, detain, treat, and disperse stormwater runoff from the site.
  - Divert surface runoff around bare areas with appropriate energy dissipation and sediment filters.

  - Routinely inspect parking and staging areas to verify that erosion and stormwater controls are implemented and functioning as designed and are appropriately maintained.
- Use suitable measures to harden and avoid or minimize damage to parking area surfaces that experience heavy use or are used during wet periods.
- Use and maintain suitable measures to collect and contain oil and grease in parking areas with high use and where drainage discharges directly to streams.
- Limit the size and extent of temporary parking or staging areas.
  - Take advantage of existing openings, sites away from waterbodies, and areas that are apt to be more easily restored to the extent practicable.
  - Use temporary stormwater and erosion control measures as needed.
  - Use applicable practices to rehabilitate temporary parking or staging areas as soon as practicable following use.
    - Re-establish original slope contours, surface, and subsurface hydrologic pathways where practicable and as opportunities arise.
    - Improve infiltration capacity on compacted areas of the site.
    - Establish effective ground cover to avoid or minimize accelerated erosion and soil loss.

Equipment Refueling and Servicing

- Refueling and servicing will occur only at approved locations, located well away from Riparian Reserves, groundwater recharge areas, and waterbodies.
- Develop a Spill Prevention Control and Countermeasures (SPCC) plan.
- Use suitable measures around vehicle service, storage, and refueling areas to fully contain spills and avoid or minimize soil contamination and seepage to groundwater.
- Provide training for all personnel handling fuels and chemicals in their proper use, handling, storage, and disposal.
  - Upon request, contractors and permit holders are required to provide documentation of proper training in handling hazardous materials.
- Use suitable measures to avoid spilling fuels, lubricants, cleaners, and other chemicals during handling and transporting.
- Storage of excess chemicals and wastes in the project area is prohibited.
- Clean up and dispose of spilled materials according to specified requirements in the SPCC plan.
- Remove service residues, used oil, and other hazardous or undesirable materials from NFS land and properly dispose them as needed during and after completion of the project.
- Report spills and initiate suitable cleanup action in accordance with applicable State and Federal laws, rules, and regulations.
  - Remove contaminated soil and other material from NFS lands and dispose of this material in a manner consistent with controlling regulations.

Naturally Occurring Asbestos (NOA)

NOA control actions will not eliminate the risk of asbestos, but provide options to reduce the release of airborne asbestos fibers from project activities (California EPA, 2002b).

Roads

- Wet road surfaces as needed.
- Cover with 2 to 4 inches of non-asbestos rock as needed.
- Conduct roadwork during periods of calm whenever possible.
- Wet side cast materials as needed.
- Use wind breaks as needed.

- Reduce driving speeds always.

Equipment

- Wet road surfaces as needed.
- Rinse vehicles and equipment as needed.
- Wet and cover each load of material.

Exposed ultramafic areas

- Wet as needed.
- For fine-textured soils with high compaction ratings, cover with 6 to 12 inches of masticated material. Soil moisture should be less than 18 percent (evaluated by forest soil scientist), and low ground pressure equipment (less than 6psi) should be used.
- Revegetate at the end of project activities.

Water Drafting

Control actions designed to protect water quantity include the following:

- Water drafting will occur at existing sites identified on the final project map.
- Water drafting from fish-bearings streams is allowed only where immediate downstream discharge is maintained at 1.5 cubic feet per second or greater.
- Water drafting shall never remove more than 50 percent of any stream discharge.

Required Monitoring

BMP monitoring is required to comply with Forest Service direction and the Regional Water Board Waiver. For Regional Water Board compliance, implementation monitoring must be completed for project activities, and effectiveness monitoring must be completed for road reconstruction activities. BMP monitoring forms[20] that will be used to evaluate project activities include:

- Vegetation A – This evaluation form assesses BMPs to protect water, aquatic, or riparian resources applied to ground-based skidding and harvesting operations.
- Vegetation C – This evaluation form assesses BMPs to protect water, aquatic, or riparian resources applied to mechanical site treatment operations. Mechanical site treatments include traditional site preparation, timber stand improvements, removal of invasive/exotic plants, and pile burning.
- Fire A – This evaluation form assesses BMPs to protect water, aquatic, or riparian resources applied during the planning and implementation of prescribed fire used to meet land management objectives.
- Roads B – This evaluation form assesses BMPs to protect water, aquatic, or riparian resources employed on Forest Service system roads and/or associated waterbody crossings after their construction or reconstruction has been completed.
- Roads C – This evaluation form assesses BMPs to protect water, aquatic, or riparian resources applied to the long-term management and maintenance of Forest Service system roads (maintenance levels 2-5).
- Roads D - This evaluation form assesses BMPs to protect water, aquatic, or riparian resources applied to maintenance level 1 roads, which also are termed stored roads.

[20] Forms are available at http://fsweb.wo.fs.fed.us/wfw/watershed/national_bmps/index.html.

Incomplete and Unavailable Information

It is unknown for certainty when project activities will be implemented. It is assumed that the activities will be implemented as soon as practicable.

Even approximately predicting the amount of sediment that will enter streams due to project activities is difficult to determine due to the numerous variables. Therefore, the results should be viewed as best guess approximations of the amount of sediment that may reach the streams, rather than accurate forecasts of what we know will happen.

Natural receiving water temperatures of the streams in the project area are unknown.

The magnitude of increased stream temperatures caused by riparian thinning is not well understood (Spies and others, 2018). Further research is needed to improve our understanding of the impacts of thinning, but there is some evidence that light thinning may not substantially increase stream temperatures.

Spatial and Temporal Context for Effects Analysis

The affected spatial area for geologic and soil resources where effects may be caused by the proposed activities is the project boundary for the Proposed Action.

The spatial area for water resources where effects may be caused is the hydrologic units (fifth field through eighth field) in which project activities will occur.

The timeframe of the hydrology analysis is five years. The potential for indirect effects is reduced over time and is often not evident within about five years of project implementation. Also, there are no known future projects beyond 2025.

Direct and Indirect Effects

Active Landslides and Inner Gorges

Logging causes increased landslide frequency, and more landslides reach streams following logging activities. (Guthrie, 2002; Wolter and others, 2012). Loss of vegetation cover and root deterioration may explain the difference between natural and logging-related landslides. In unlogged areas, vegetation and root systems provide support to slopes by anchoring soil and sediment, and the canopy slows precipitation from infiltrating the surficial material immediately. Managers or decision-makers of steep land forestry operations need to consider the likelihood and consequences of logging-related landslides and evaluate whether such risks are acceptable.

There are about 80 square feet of an active landslide and about 6 acres of inner gorges in the proposed project area. No equipment is allowed in active landslide areas and inner gorges, so landslides (as direct effects) are expected to be negligible. Timber production in active landslide areas and inner gorges is not allowed because it does not comply with the Forest Plan and cannot be done without causing irreversible damage to soils productivity and/or watershed conditions. Fuels management activities however are allowed, which may include pruning and thinning. Pruning and thinning will cause loss of vegetation cover and root deterioration however, which can cause the indirect effect of an increased risk of landslides. To reduce this risk, it is preferable to thin and prune very lightly several times rather than all at once.

Soil Stability and Erosion Risk

The risk of erosion will increase during implementation in the project area, but the effects will not be significant (see Sediment section below).

Surface Organic Matter

The sizes, amount, and distribution of surface organic matter will stay about the same if the proposed action is implemented.

Soil Organic Matter and risk of SOM Loss

SOM loss will occur during implementation in the project area due to small amounts of topsoil displacement, but the effects will be negligible.

Compaction Risk

Compaction will increase during implementation in the project area, but the effects will be minor and well within the soil quality standards.

Sediment

Direct effects include sediment that immediately enters streams as a result of project activities. Some sediment is expected to directly enter streams at road/stream crossings, but the implementation of BMPs is expected to make direct effects negligible.

Sediment will reach streams as an indirect effect of project activities. Most of the sediment will be produced by project activities in Riparian Reserves within about 150 feet of streams. This indirect effect can be minimized by implementing project BMPs, but it can't be avoided because the Riparian Reserves are not avoided. The sediment caused by thinning and fuels treatments can be compensated for by treating the identified legacy sediment sites. The amount of sediment produced by project activities can be estimated by calculating the ERA of project activities near streams and converting to tons of sediment per year[21] (Table 3). After the first year of implementation, an increased amount of sediment (about 590 tons) will reach streams. However, the annual impacts of the thinning and fuels treatments will decline over time. Once road improvements are implemented, the annual impact will be a reduction in the amount of sediment delivered to streams. The second year after implementation will see a reduction in sediment (about 50 tons) reaching streams. This means that about 50 tons more sediment will be removed from streams due to treating roads than will be produced from the impacts of thinning and fuels treatments. By 2023, there will be a net reduction in the amount of sediment entering streams, and the positive effect (negative amount of sediment) will continue over time as long as the road improvements are maintained.

Table 3. Tons of sediment produced per year by project activities for five years[22].

[21] The historic sediment load for the South Fork Trinity River and its tributaries from roads is estimated to be about 193 tons per square mile per year (U.S. EPA, 1998). The area of the South Fork Trinity River sub-basin is about 931 square miles, so roads produce about 180,000 tons of sediment per year. There are about 2,943 miles of road in the South Fork Trinity River sub-basin. Assuming an average road width of about 25 feet, there are about 8,918 acres of road. Therefore, roads produce about 20.1 tons per acre of road per year. The sediment produced by roads is about 83 percent controllable (U.S. EPA, 1998), so a properly reconstructed road would be expected to produce about 3.4 tons per acre of road per year.

[22] It is assumed that the thinning and initial fuel treatments will occur in 2019, the road improvements will occur in 2020, and the follow-up prescribed fire will occur in 2023. Owing to the difficulty in predicting the amount of sediment that will enter streams due to the numerous variables, these results should be viewed as best guess

Activity	Year					5 Year Total
	2020	2021	2022	2023	2024	
Mechanized Thin	250	210	190	180	170	1000
Mechanized Pile and Burn	250	210	70	70	60	660
Cable Thin	90	80	30	0	0	200
Initial Prescribed Fire	0	110	30	0	0	140
Road Upgrade	0	-660	-660	-660	-660	-2600
Road Closure	0	-270	-270	-270	-270	-1100
Follow-up Prescribed Fire	0	0	0	0	190	190
All Project Activities	590	-50	-340	-410	-430	-640

Temperature and Stream Shading

Temperatures of streams are effected by a loss of riparian vegetation due to an increase of solar radiation reaching the stream surface. A previously forested farm stream in a mountainous watershed in western North Carolina had a maximum temperature of 79 °F, whereas a nearby forest stream of similar size had a maximum temperature of 66 °F; it was concluded that shading was the key to controlling the stream temperatures, which was further emphasized by the fact that the farm stream temperature dropped to 68 °F after meandering through just 400 feet of forest and brush cover (Greene, 1950). The annual maximum stream temperature increased from 57 °F to 85 °F one year after clear-cut logging on a small watershed in Oregon's coast range; as riparian vegetation became reestablished, summer maximum temperatures approached pre-logging levels within about six years after logging has completed (Brown and Krygier, 1970).

The effect of riparian thinning on summer stream temperatures is correlated positively with the amount of forest canopy removed and inversely with the distance from the stream that the activity occurs; however, the amount of shade lost from a given thinning treatment can be highly variable (Spies and others, 2018). The amount of shade lost can be smaller than the amount of tree basal area removed. The removal of 10 to 20 percent of the basal area had no measurable effect on angular canopy density in riparian buffers of boreal mixed wood forest streams near White River, Ontario (Kreutzweiser and others, 2009). Any shade losses and stream temperature increases from riparian thinning are likely to be short lived because riparian forest canopies can close within three years after thinning (Chan and others, 2006; Yeung and others, 2017).

Direct effects on temperature will be caused by a reduction in stream shading due to riparian thinning. The net reduction in temperature is very uncertain, but the range of possible direct effects can be estimated. At the low end, a twenty percent reduction in canopy cover could have a negligible effect on stream shading and temperature. This effect has been reported previously (Spies and others, 2018). At the high end, it is assumed that a twenty percent reduction in riparian canopy cover of a stream reach could cause at most a ten percent reduction in stream shading. A ten percent reduction in stream shading could result in a temperature increase of about 4 °F[23].

Indirect effects on temperature caused by project activities are expected to be a reduction in stream temperatures. The stream shading losses and stream temperature increases from riparian thinning are assumed to be short lived, because riparian forest canopies have reportedly closed within three years after

approximations of the amount of sediment that may reach streams, rather than accurate forecasts of what will happen.

[23] This estimate is derived using the regression equation that describes stream temperature as a function of stream shading.

thinning. Stream temperatures are expected to decline as the forest canopy closes. It is expected that temperatures will reduce to at least pre-project levels. Temperatures may reduce even further if the thinning successfully promotes increased height of the remaining trees which could result in more stream shading.

LWD in Streams

Direct effects on LWD in streams may be a small increase in LWD because a few trees could be felled into streams. No trees will be removed from streams.

Indirect effects from thinning activities in Riparian Reserves will be a reduction in the potential for future recruitment of LWD in streams. The drainages of Dubakella Creek and Headwaters Hayfork Creek, and the sub-drainage (1801021203010303) of South Fork Goods Creek are presently deficient in LWD compared to reference streams, so no trees will be removed from the EEZs of perennial streams; trees that are thinned within the EEZs of perennial streams should be felled in the direction of the stream and left.

Indirect effects from fuels management activities will likely be an increase in the potential for future recruitment of LWD in streams. South Fork Goods Creek in particular is presently deficient in LWD compared to reference streams and will likely benefit from fuels management activities.

Cumulative Effects

Sediment

Past disturbances include: grazing, road construction, powerline development, agricultural crops (including marijuana), mines, fires and fire suppression, road decommissioning, timber harvest, emergency exemptions, and fuels treatments. Present and future foreseeable actions and projects that are modeled include: unlogged timber harvests, 2015 Fire Reforestation, Beegum Watershed Restoration, Gemmill Thin, and Trinity Post Fire Hazard Reduction and Salvage.

Cumulative watershed effects (CWE) have been analyzed for each watershed, sub-watershed, drainage, and sub-drainage in the project area (Table 4). Although a change in the risk ratio of several percent relative to the baseline condition is common (especially for drainages and sub-drainages), these changes are considered to be fairly negligible. Only the changes that cause a change in the disturbance level (e.g. moderate in the baseline CWE and high in the Proposed Action CWE) are specifically addressed in the text. No hydrologic units are over the TOC (very high disturbance level). In Headwaters Hayfork Creek, the disturbance level of one sub-drainage (1801021203010101) is elevated to moderate the first year after the project is implemented, but it reduces again to low by the third year after implementation. A second sub-drainage (1801021203010102) of Headwaters Hayfork Creek is projected to have a disturbance level elevated to moderate for 5 years after implementation. In Stringbean Creek-Goods Creek, the disturbance level of the drainage is elevated to moderate for five years after the project is implemented. Two sub-drainages (1801021203010301 and 1801021203010303) of Stringbean Creek-Goods Creek that have low disturbance levels before the project is implemented are projected to have moderate disturbance levels five years after implementation. In Halls City Creek-Wilson Creek, the disturbance levels of the drainage and two sub-drainages (1801021203010401 and 1801021203010403) are moderate before the project is implemented, but are projected to have low disturbance levels five years after implementation.

Table 4. Cumulative effects ERA if all of the project is implemented as assumed in Table 3.

Hydrologic Unit				2020		2022		2024		Disturbance Level
5	6	7	8	ERA (Acres)	Risk Ratio (% of TOC)	ERA (Acres)	Risk Ratio (% of TOC)	ERA (Acres)	Risk Ratio (% of TOC)	

Hydrologic Unit				2020		2022		2024		Disturbance Level
5	6	7	8	ERA (Acres)	Risk Ratio (% of TOC)	ERA (Acres)	Risk Ratio (% of TOC)	ERA (Acres)	Risk Ratio (% of TOC)	
Upper Hayfork Creek				6438	35	5625	31	5309	29	Low
	Dubakella Creek			2041	35	1659	28	1609	27	Low
		Headwaters Hayfork Creek		412	38	364	34	377	35	Low
			1801021203010101	155	40	133	34	137	35	Moderate to Low
			1801021203010102	135	44	122	40	128	42	Moderate
			1801021203010103	122	31	110	28	112	29	Low
		Dubakella Creek		223	33	179	27	184	28	Low
			1801021203010201	78	25	57	19	59	19	Low
			1801021203010202	146	40	122	33	126	35	Low
		Stringbean Creek-Goods Creek		560	44	503	39	527	41	Moderate
			1801021203010301	85	48	72	41	74	43	Moderate
			1801021203010302	25	16	22	14	22	15	Low
			1801021203010303	95	39	87	36	116	48	Low to Moderate
			1801021203010304	226	76	203	68	194	65	Moderate
			1801021203010305	133	33	122	30	122	30	Low
		Halls City Creek-Wilson Creek		545	58	411	44	355	38	Moderate to Low
			1801021203010401	201	54	155	41	131	35	Moderate to Low
			1801021203010402	106	39	93	34	92	33	Low
			1801021203010403	184	63	130	45	105	36	Moderate to Low
		Chanchelulla Gulch-Shiell Gulch		278	22	178	14	143	12	Low
			1801021203010501	79	23	61	18	55	16	Low
			1801021203010502	75	26	43	15	32	11	Low

Temperature and Stream Shading

The amount that stream temperatures are currently above natural conditions due to past disturbances is unknown. Effects on stream temperatures from the Trinity Post Fire Hazard Reduction and Salvage project are expected to be small and negligible (Schmerge and others, 2017). Effects on stream temperatures from the 2015 Fire Reforestation project are expected to be small and unquantifiable (Schmerge, 2016). A small portion of the Beegum Watershed Restoration Project is located in the Dubakella sub-watershed, but no direct or indirect effects on temperature are reported (Mai, 2018), so it is concluded that this project will contribute no cumulative effects. No direct or indirect effects on temperature are reported for the Gemmill Thin Project (Mai, 2018), so it is concluded that this project will contribute no cumulative effects.

Stream temperatures may temporarily increase by zero to four degrees Fahrenheit above current temperatures if the Proposed Action is implemented. Therefore, this stream temperature increase most likely will be lower than the maximum five degree Fahrenheit increase above natural conditions allowed by the Regional Water Board Basin Plan. The stream temperature increases from riparian thinning are assumed to be negligible after about three years. After three years, if project thinning successfully promotes increased tree growth of the remaining trees, then increased stream shading and reduced stream temperatures may occur.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

The Proposed Action complies with the Land and Resource Management Plan. Standards and guideline for geology, soils, water, and Riparian Reserves related to this project (LRMP, page 4-25) are followed. Soil Quality Standards are applied to protect soil productivity. Timber land suitability criteria are complied with. The desired conditions of soil and water resources are met by maintaining or improving soil productivity and water quality.

The Aquatic Conservation Strategy objectives related to physical sciences resources are met by the project.

- The physical integrity of the aquatic system, including shorelines, banks, and bottom configurations is maintained. The width of the EEZ for perennial streams should be sufficient to make streambank erosion negligible. The width of the EEZ for intermittent streams is too narrow to be expected to fully prevent streambank erosion, but the implementation of the project BMPs should minimize streambank erosion. LWD is an important element necessary for creating physical complexity of stream channels. LWD is presently deficient in some of the streams in the project area. It is expected that LWD will be at least retained if the project is implemented because no LWD that is located in streams will be removed. It is likely that LWD will increase if the project is implemented for several reasons. First, no logs that are felled within the EEZ of perennial streams will be removed unless approved by a hydrologist or fish biologist. Second, prescribed fires (especially in the area around South Fork Good Creek) is expected to create snags that will be available for future recruitment of LWD in streams.
- Water quality is maintained over time although there may be some small increases in sediment and temperature immediately after project implementation. Owing to the proximity of the project area to streams, it will not be possible to completely avoid the impact that sediment from project related activities will have on streams. However, BMPs for all project activities are designed to minimize the impact of sediment. Also, the treatment of the identified legacy sediment sites in the Dubakella sub-watershed will sufficiently compensate for the impact of the project activities such that sediment levels are expected to decline below pre-project levels after all project activities and connected actions are completed. Immediately after implementation, stream temperatures may increase somewhat, but most likely by a lesser amount than allowed by the Regional Water Board Basin Plan. Stream temperatures most likely will return to pre-project levels after about three years due to canopy closure, and may decrease even more over time due to increased tree growth.
- The sediment regime under which aquatic ecosystems evolved is maintained (see the discussion of sediment in the paragraph above about water quality).
- In-stream flows are maintained. Water drafting will be allowed only at approved sites with sufficiently low pumping rates such that the required in-stream flows are maintained. Reconstruction of road/stream crossings at legacy sediment sites will divert flows around the site and back into the stream channel.
- The Proposed Action will have no effect on the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

This project complies with all relevant federal laws including NEPA, the National Forest Management Act, the Clean Water Act, and the Clean Air act.

This project complies with the Porter-Cologne Water Quality Control Act, the Regional Water Board Basin Plan, the Waiver, and the sediment TMDL for the South Fork Trinity River and Hayfork Creek.

This project complies with all Forest Service directives regarding geology, soils, and water.

Extraordinary Circumstances

There are no extraordinary circumstances related to the Proposed Action. Floodplains, wetlands, and municipal watersheds are present, but the degree of the potential effects on these resources is minimal.

Floodplains in the Dubakella sub-watershed are generally narrow due to the steep terrain and extend from the streams to the elevation of a 100-year flood. Short-term impacts will be minimal as long as the best management practices are implemented. There will be no long-term adverse impacts associated with the modification of floodplains as long as the legacy sediment sites are treated.

Wetlands in the Dubakella sub-watershed are riverine and are generally present from the streams to the extent of riparian vegetation. No wetlands will be destructed or lost, and the degradation of wetlands will be minimized by implementing project BMPs. Treatment of the legacy sediment sites will preserve and enhance the natural and beneficial values of wetlands

Municipal water supply is a beneficial use of water in the Dubakella sub-watershed. Project activities will not impact the quality or availability of drinking water.

Other Agencies and Individuals Consulted

North Coast Regional Water Quality Control Board

June 19, 2018. The Regional Water Board received the scoping letter from the Forest Service.

July 25, 2018. The Forest Service received a scoping comments letter from the Regional Water Board.

> The project appears to fall under Category B of the Waiver (Robinson, 2018). The project must be in compliance with the sediment total maximum daily load (TMDL) that has been developed for the watershed. For enrollment, after project approval by the USFS and at least 30 days prior to commencement of on-the-ground activities, a Notice of Intent (NOI) and Waiver Application shall be filed with the Regional Water Board. All active and potential legacy sediment sites must be identified, inventoried, prioritized, scheduled, and implemented for treatment within the project area. The USFS shall include specific on- the- ground prescriptions designed to meet the USFS Best Management Practices (BMP) within the environmental document prepared pursuant to the National Environmental Policy Act (NEPA). The USFS shall provide copies of the Waiver to contractors, USFS volunteers, and any other third parties specified in the Waiver, and notify them of their responsibilities to comply with the Waiver. USFS shall manage and maintain designated riparian zones to ensure retention of adequate vegetative cover that results in natural shade conditions, within 300 feet slope distance on each side of fish- bearing streams, 150 feet slope distance on each side of perennial streams, and 100 feet slope distance on each side of intermittent streams, or the site potential tree height distance on each side of the stream, whichever is greatest (per ACS). Measures to mitigate water quality impacts should be included in the design of the project.

August 22, 2018. Emailed the draft legacy sediment site plan to the Regional Water Board.

> Recommended that a legacy sediment sites trade might be beneficial.

August 30, 2018, Field trip with Maggie Robinson, Galen Anderson, and David Schmerge.

Acronyms

ACS – Aquatic Conservation Strategy

ATCM – Airborne Toxic Control Measure

BFW – bankfull width

BMP – best management practice

CWA – Clean Water Act

CWE – cumulative watershed effects

DWR – Department of Water Resources

EHR – erosion hazard rating

EIS – environmental impact statement

EPA – Environmental Protection Agency

ERA – equivalent roaded area

EEZ – equipment exclusion zone

FSDMP – Forest Soil Disturbance Monitoring Protocol

FSH – Forest Service Handbook

FSM – Forest Service Manual

GIS – geographic information system

GPS – Global Positioning System

LRMP – Land and Resource Management Plan

LTSP – long term soil productivity

LWD – large woody debris

MVUM – Motor Vehicle Use Map

MWMT – maximum weekly maximum temperature

n.d. – no date

NCRWQCB – North Coast Regional Water Quality Control Board

NEPA – National Environmental Policy Act

NFMA – National Forest Management Act

NOA – naturally occurring asbestos

SOM – soil organic matter

SPCC – Spill Prevention Control and Countermeasures

SQS – soil quality standard

TMDL – total maximum daily load

TOC – threshold of concern

WEPP – Water Erosion Prediction Project Model

References Cited

Asarian, J.E. 2016. Stream temperatures in the South Fork Trinity River Watershed 1989-2015. Prepared for: The Watershed Research and Training Center.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. In: Streamshide management: forestry and fisheries interactions. E.O. Salo and T.W. Cundy (Eds.) Institute of Forest Research, University of Washington, Seattle, WA, USA. 191-232.

Broadmeadow, S., and T. R. Nisbit. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practice. Hydrology and Earth System Sciences, 8(3), 286-305.

Brown, G.W., and J.T. Krygier. 1970. Effects of clearcutting on stream temperature. Water Resources Research. 6(4): 1133-1139.

California Department of Water Resources, Northern District. 1979. South Fork Trinity River watershed erosion investigation.

California Environmental Protection Agency, Air Resources Board. 2002a. Naturally-occurring asbestos general information.

California Environmental Protection Agency, Air Resources Board. 2002b. Fact Sheet #3 – Ways to control naturally-occurring asbestos dust.

California Environmental Protection Agency, North Coast Regional Water Quality Control Board. 2006. Desired salmonid freshwater habitat conditions for sediment-related indices.

California Environmental Protection Agency, North Coast Regional Water Quality Control Board. 2011. Water quality control plan for the North Coast Region.

California Environmental Protection Agency, North Coast Regional Water Quality Control Board. 2014. Staff report supporting the policy for the implementation of the water quality objectives for temperature and action plan to address temperature impairment in the Mattole River Watershed, action plan to address temperature impairment in the Navarro River Watershed, and action plan to address temperature impairment in the Eel River Watershed.

California Environmental Protection Agency, North Coast Regional Water Quality Control Board. 2015a. Waiver of waste discharge requirements for nonpoint source discharges related to certain federal land management activities on National Forest System lands in the North Coast Region. Order No. R1- 2015- 0021.

California Environmental Protection Agency, North Coast Regional Water Quality Control Board. 2015b. California Regional Water Quality Control Board North Coast Region monitoring and reporting program no. R1- 2015- 0021 for United States Forest Service waiver of waste discharge requirements for nonpoint source discharges related to certain federal land management activities on National Forest System lands In the North Coast Region.

California Environmental Protection Agency, State Water Resources Control Board. 2017. 2014 and 2016 California integrated report Clean Water Act sections 303(d) and 305(b).

Carter, K. 2008. Effects of temperature, dissolved oxygen/total dissolved gas, ammonia, and pH on salmonids: implications for California's north coast TMDLs. North Coast Regional Water Quality Control Board.

Chan, S.S., D.J. Larson, K.G. Maas-Hebner, W.H. Emmingham, S.R. Johnston, and D.A. Mikowski. 2006. Overstory and understory development in thinned and underplanted Oregon Coast Range Douglas-fir stands. Canadian Journal of Forest Research. v. 36. p. 2696-2711.

Everest, F. H., and G. H. Reeves. 2007. Riparian and aquatic habitats of the Pacific Northwest and Southeast Alaska: Ecology, Management History, and Potential Management Strategies. U.S. Department of Agriculture, Forest Service. Pacific Northwest Research Station. General Technical Report PNW-GTR-692.

Gomez, A., M. J. Singer, and W. R. Horwath. 2002. Soil compaction effects on growth of young ponderosa pine following litter removal in California's Sierra Nevada. Soil Science Society of America Journal, v. 66, p. 1334-1343.

Greene, G. E. 1950. Land use and trout streams. J. Soil Water Conserv., 5, 125-126.

Guthrie, R. H. 2002. The effects of logging on frequency and distribution of landslides in three watersheds on Vancouver Island, British Columbia. Geomorphology. v. 43. p. 273-292.

Haskins, D.M., 1983. An overview of the use of cumulative watershed impact analysis, Shasta-Trinity National Forest, internal publication.

Haskins, D.M., 1986. A management model for evaluating cumulative watershed effects: Proceedings from the California Watershed Management Conference, West Sacramento, CA, November 18-20, 1986, p. 125-130.

Hawes, E., and M. Smith. 2005. Riparian buffer zones: functions and recommended widths. Yale School of Forestry and Environmental Studies.

Kreutzweiser, D.P., S.S. Capell, and S.B. Holmes. 2009. Stream temperature responses to partial-harvest logging in riparian buffers of boreal mixedwood forest watersheds. Canadian Journal of Forest Research. v. 39. p. 497-506.

Liechty, H.O., M.G. Shelton, K.R. Luckow and D.J. Turton. 2002. Impacts of shortleaf pine-hardwood forest management on soils in the Ouachita Highlands: a review. Southern Journal of Applied Forestry 26 (1). p. 43-51.

Mai, C. 2010. Gemmill SEIS hydrologist report. Shasta-Trinity National Forest.

Mai, C. 2018. Beegum watershed restoration project hydrology report. Shasta-Trinity National Forest.

Moring, J.R. 1982. Decrease in stream gravel permeability after clear-cut logging: an indication of intragravel conditions for developing salmonid eggs and alevins. Hydrobiologica, 88, 295-298.

Pacific Watershd Associates. 1994. Action plan for restoration of the South Fork Trinity River watershed and its fisheries. Prepared for the U.S. Bureau of Reclamation and the Trinity River Task Force. http://www.krisweb.com/biblio/sft_usbor_pwa_1994_sftplan/pwa1.htm

Page-Dumroese, D.S., A.M. Abbott, and T.M. Rice. 2009. Forest Soil Disturbance Monitoring Protocol, Volume 1: Rapid Assessment. Gen. Tech. Report WO-82a, U.S. Department of Agriculture, Forest Service.

Pickle, R., J. Merrifield, G. Anderson, and D. Schmerge. 2019. South Fork Trinity River above Powell Creek in-stream monitoring draft report.

Ries III, K.G., J.K. Newson, M.J. Smith, J.D. Guthrie, P.A. Steeves, T.A. Haluska, K.A. Kolb, R.F. Thompson, R.D. Santoro, and H.W. Vraga. 2017. StreamStats, version 4. U.S. Geological Survey Fact Sheet 2017-3046.

Robinson, M. 2018. Scoping Comments: 2018 - STNF Dubakella plantations insect and disease project. North Coast Regional Water Quality Control Board.

Schmerge, D. 2016. 2015 fire reforestation project hydrology report. Shasta-Trinity National Forest.

Schmerge, D., B. Rust, and D. Veich. 2017. Trinity post fire hazard reduction and salvage project physical sciences report. Shasta-Trinity National Forest.

Spies, T. A., P. A. Stine, R. Gravenmier, J.W. Long, and M.J. Reilly. 2018. Synthesis of science to inform land management within the Northwest Forest Plan area. Volume 2. U.S. Department of Agriculture. Forest Service. Pacific Northwest Research Station.

U.S. Army Corps of Engineers. 1991. Buffer strips for riparian zone management. Waltham, MA: New England Division. 56 p.

U.S. Department of Agriculture, Forest Service. 1990. FSM 2500 – Watershed and air management, WO Amendment 2500-90-1, Chapter 2530 – Water Resource Management.

U.S. Department of Agriculture, Forest Service. 1995a. Final Environmental Impact Statement, Shasta-Trinity National Forest Land and Resource Management Plan.

U.S. Department of Agriculture, Forest Service. 1995b. Shasta-Trinity National Forest Land and Resource Management Plan.

U.S. Department of Agriculture, Forest Service. 2005. Stream condition inventory (SCI) technical guide – Pacific Southwest Region.

U.S. Department of Agriculture, Forest Service. 2010. FSM 2500 – Watershed and air management, Chapter 2550 – Soil Management.

U.S. Department of Agriculture, Forest Service. 2012. National best management practices for water quality management on National Forest System lands volume 1: National core BMP technical guide.

U.S. Department of Agriculture, Forest Service. 2014. FSH 1909.15 – National Environmental Policy Act Handbook, Chapter 30 – Categorical Exclusion from documentation, Amendment No. 1909.15-2014-1

U.S. Department of Agriculture, Forest Service. 2015. FSM 2800 – Minerals and geology, Chapter 2880 – Geologic resources, hazards, and services.

U.S. Department of Agriculture, Forest Service. n.d.a. Naturally-occurring asbestos. Retrieved from https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=STELPRDB5363833 on November 23, 2018.

U.S. Department of Agriculture, Forest Service. n.d.b. Where the earth's crust collides, serpentine is born. Retrieved from https://www.fs.fed.us/wildflowers/beauty/serpentines/geology.shtml on November 23, 2018.

U.S. Department of Agriculture, Forest Service, Region 5. 2011. R5 FSH 2509.22 – Soil and water conservation handbook, Chapter 10 – Water quality management handbook, Amendment 2509.22-2011-1.

U.S. Department of Agriculture, Forest Service, Region 5. 2017. R5 FSH 2509.22 – Soil and water conservation handbook, Chapter 50 – Soil Erosion Hazard Rating, Supplement 2509.22-2017-1.

U.S. Department of Agriculture, Forest Service, Region 5. 2017. FSM 2500 – Watershed and air management, Chapter 2550 – Soil Management, Supplement 2500-2017-1.

U.S. Department of Agriculture, Forest Service, Shasta-Trinity National Forest. 1998. Upper Hayfork Creek Watershed Analysis.

U.S. Department of Agriculture, Forest Service, Shasta-Trinity National Forest. 2013. Dubakella Creek S.C.I. Report.

U.S. Environmental Protection Agency, Region 9. 1998. South Fork Trinity River and Hayfork Creek sediment total maximum daily loads.

U.S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Water Quality Standards. Region 10, Seattle, WA. EPA 910-B-03-002. 49pp.

Weaver, W.E., E.M. Weppner, and D.K. Hagans. 2015. Handbook for forest, ranch and rural roads: a guide for planning, designing, constructing, reconstructing, upgrading, maintaining and closing wildland roads (Rev. 1st ed.). Mendocino County Resource Conservation District, Ukiah, California.

Wolter, A., B. Ward, and T. Millard. 2010. Instability in eight sub-basins of the Chilliwack River Valley, British Columbia Canada: A comparison of natural and logging-related landslides. Geomorphology. v. 120. p. 123-132.

Yeung, A.C.Y, A. Lecerf, and J.S. Richardson. 2017. Assessing the long-term ecological effects of riparian management practices on headwater streams in a coastal temperate rainforest. Forest Ecology and Management. v. 384. p. 100-109.

Appendix A – Map of Landslides and Inner Gorges in the Dubakella Sub-watershed

Appendix B – Map of Ultramafic Rock in the Dubakella Sub-watershed

Appendix C – Map of Soils in the Dubakella Sub-watershed

Appendix D – Legacy Sediment Site Report for the Dubakella Plantations Insect and Disease Project